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(12) **United States Patent**
Takada

(10) **Patent No.: US 10,766,733 B2**
(45) **Date of Patent: Sep. 8, 2020**

(54) **ELECTRIC WIRE PROCESSING APPARATUS, ELECTRIC WIRE PROCESSING METHOD, AND ELECTRIC WIRE HOLDING STRUCTURE**

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(72) Inventor: **Kazuhiko Takada**, Makinohara (JP)

(73) Assignee: **Yazaki Corporation**, Minato-ku, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 182 days.

(21) Appl. No.: **15/912,649**

(22) Filed: **Mar. 6, 2018**

(65) **Prior Publication Data**

US 2018/0257903 A1 Sep. 13, 2018

(30) **Foreign Application Priority Data**

Mar. 8, 2017 (JP) 2017-043675

(51) **Int. Cl.**
B65H 54/58 (2006.01)
H01B 13/012 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B65H 54/58*** (2013.01); ***B65H 51/14*** (2013.01); ***B65H 51/18*** (2013.01); ***B65H 57/16*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC B65H 51/14; B65H 51/18; B65H 54/58; B65H 54/62; B65H 65/00; B65H 75/28;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,948,675 B2 * 9/2005 Frommenwiler B65H 54/56 242/362.2

FOREIGN PATENT DOCUMENTS

EP 2790191 A1 10/2014
JP S56-150789 U 11/1981
(Continued)

OTHER PUBLICATIONS

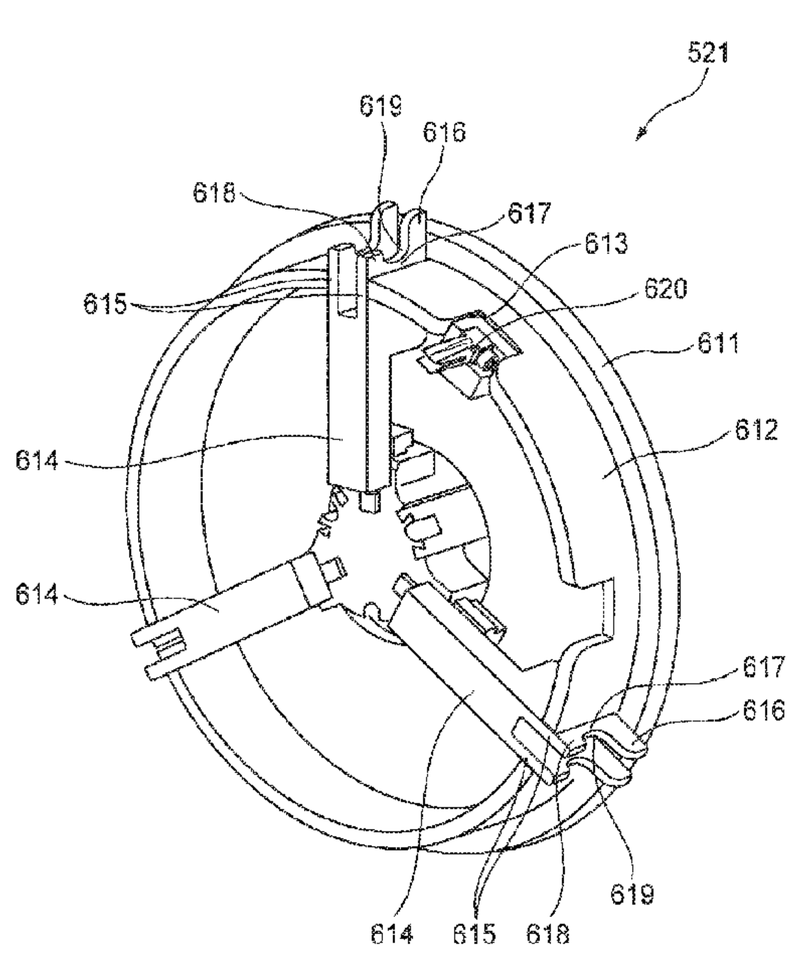
Jan. 15, 2019—(JP) Notification of Reasons for Refusal—App 2017-043675.

Primary Examiner — William E Dondero
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

An electric wire processing apparatus includes a gripping mechanism that grips a part of an electric wire, a driving mechanism that drives the gripping mechanism, an electric wire winding mechanism that winds the electric wire, and a rotating mechanism that rotates and drives the electric wire winding mechanism. The electric wire winding mechanism includes a winding drum, an electric wire clip provided on the winding drum to hold a leading end of the electric wire, and a holding member that holds an electric wire bundle. The driving mechanism moves the gripping mechanism toward the electric wire clip to hold the leading end on the electric wire clip, the rotating mechanism rotates the winding drum so that the electric wire is wound around the winding drum, and the holding member holds the electric wire bundle wound around the winding drum in the annular shape.

9 Claims, 43 Drawing Sheets



(51) **Int. Cl.**

B65H 75/28	(2006.01)
B65H 51/14	(2006.01)
B65H 51/18	(2006.01)
B65H 65/00	(2006.01)
B65H 57/16	(2006.01)
H01R 43/28	(2006.01)

(52) **U.S. Cl.**
CPC ***B65H 65/00*** (2013.01); ***B65H 75/28*** (2013.01); ***H01B 13/01209*** (2013.01); *B65H 2701/34* (2013.01); *H01B 13/01236* (2013.01); *H01R 43/28* (2013.01)

(58) **Field of Classification Search**
CPC H01B 13/0036; H01B 13/01209; H01B 13/01236; H01R 43/00; H01R 43/28
USPC 242/472.5
See application file for complete search history.

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	H07-192550	A	7/1995
JP	H11-228026	A	8/1999
JP	2004-256300	A	9/2004
JP	2009-004233	A	1/2009
JP	2010-092788	A	4/2010
JP	2010-287369	A	12/2010
JP	2011-216363	A	10/2011
JP	2012-104425	A	5/2012
JP	2013-152856	A	8/2013

* cited by examiner

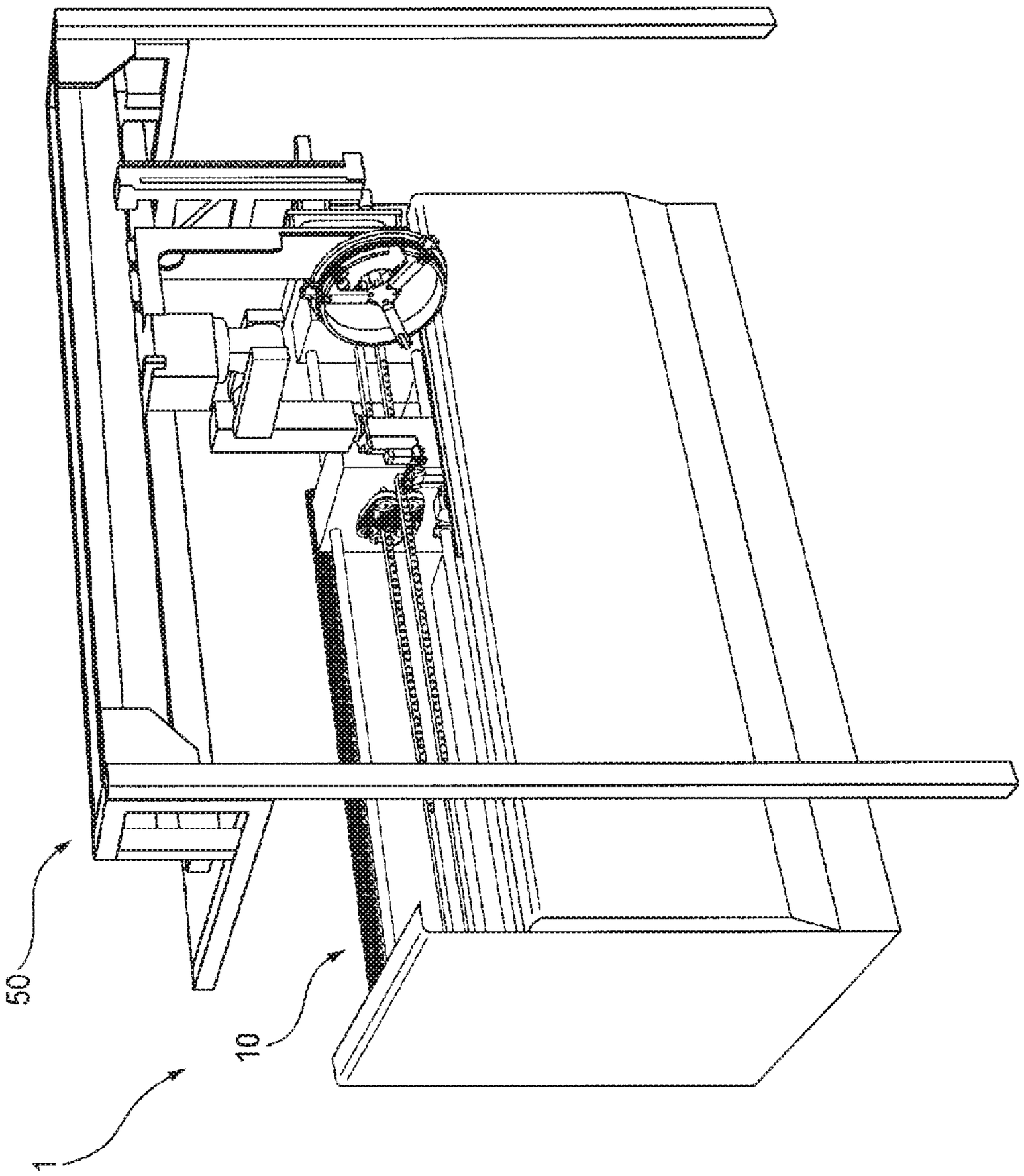
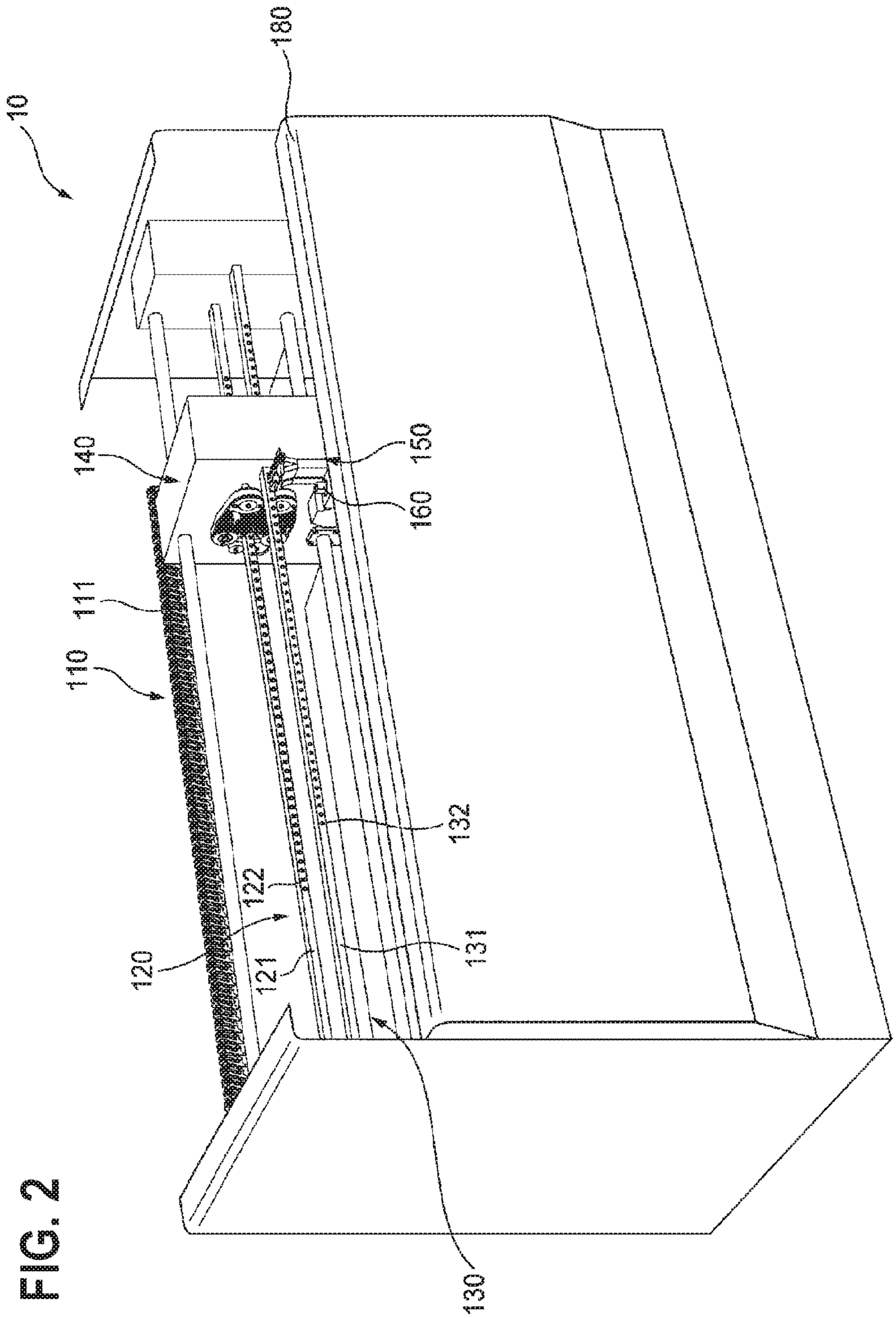


FIG. 1



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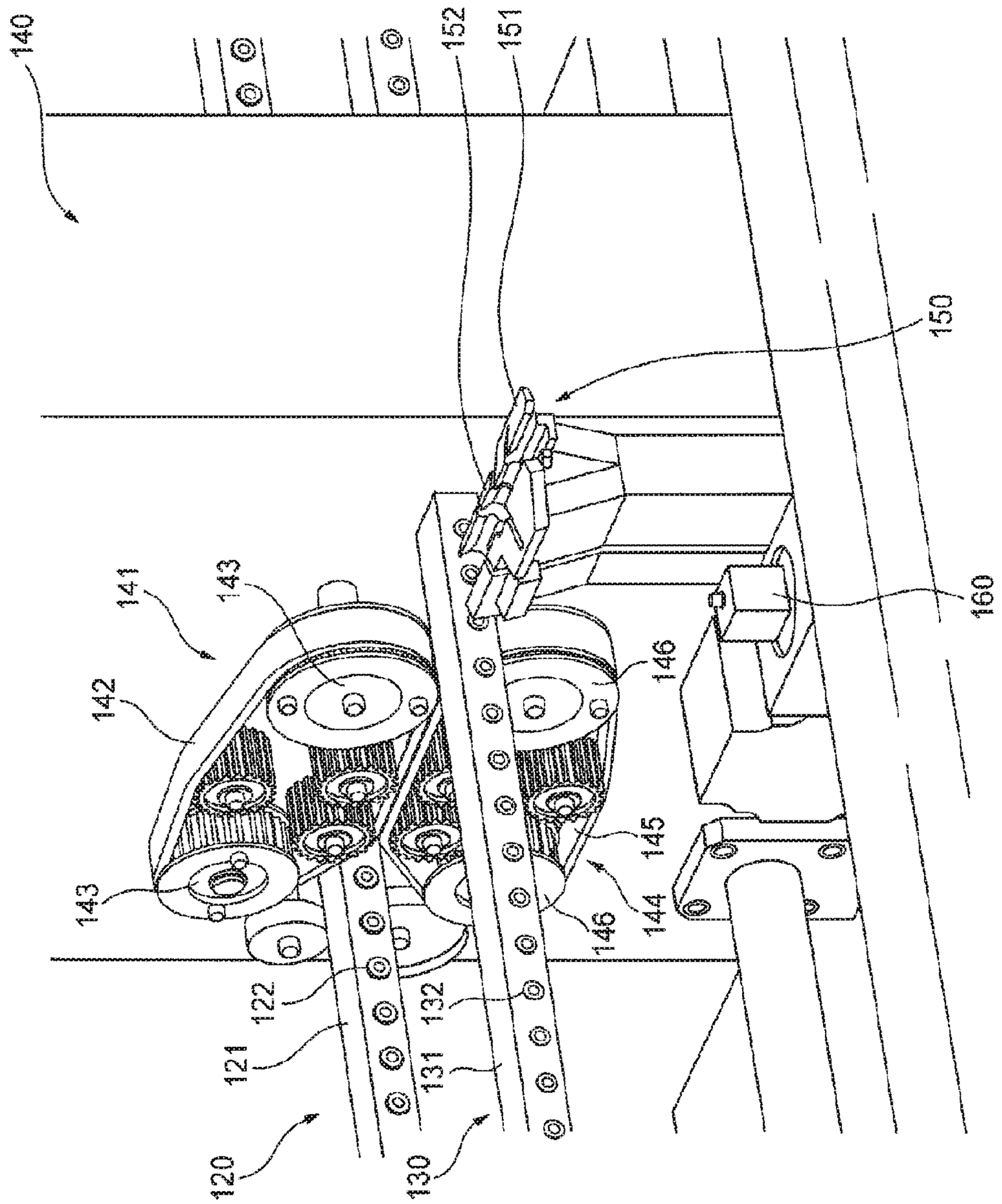
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FIG. 3

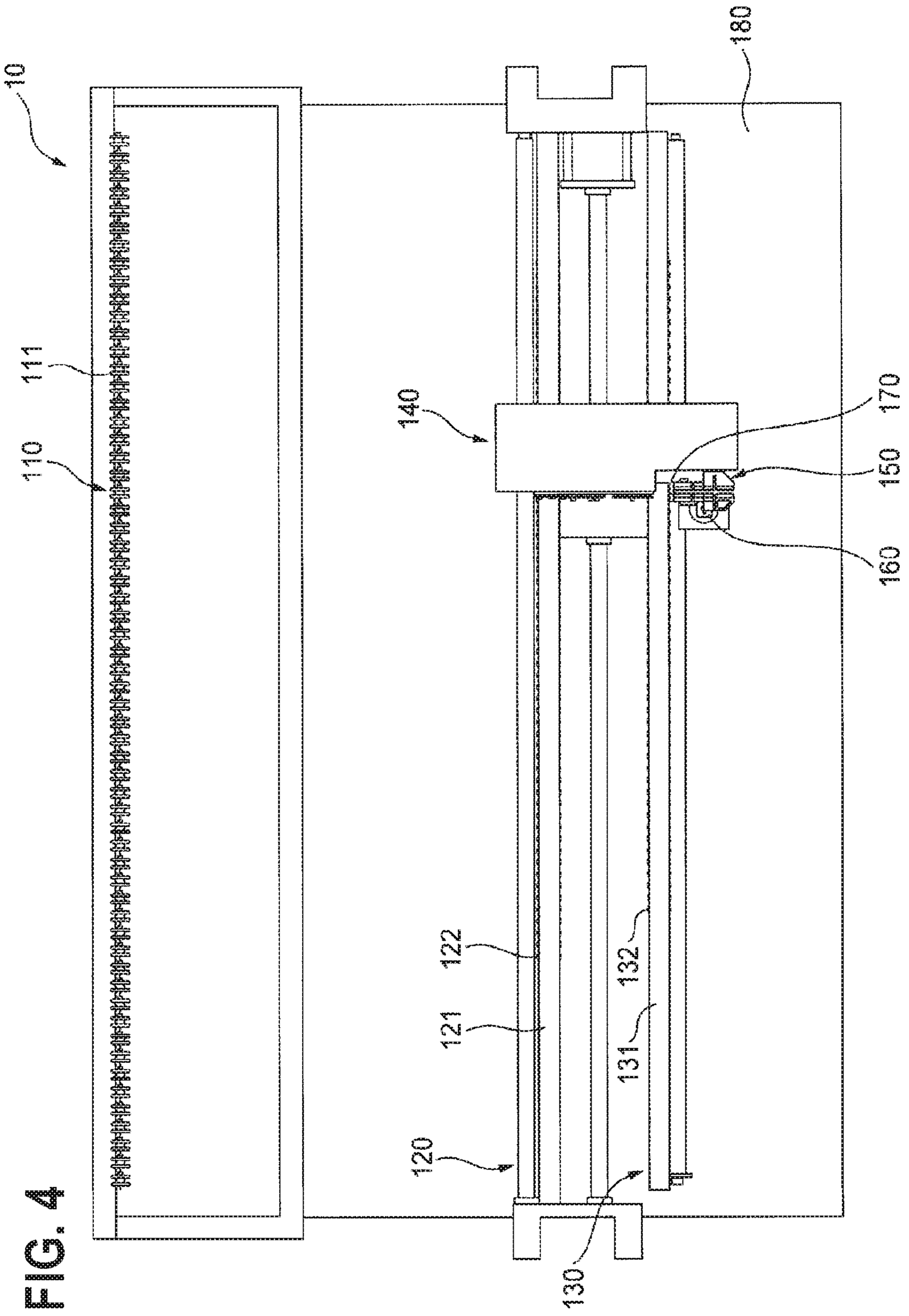


FIG. 4

FIG. 5

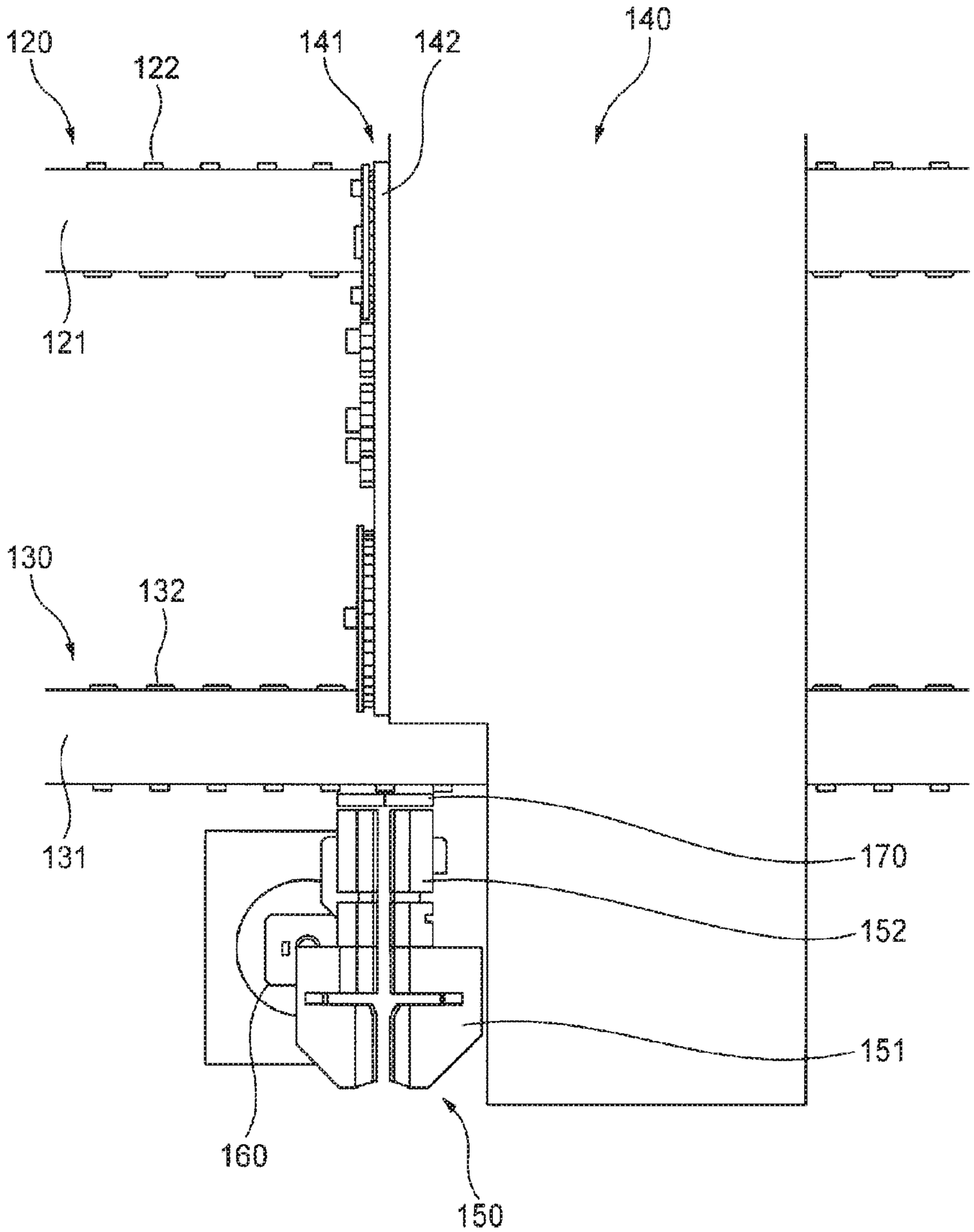
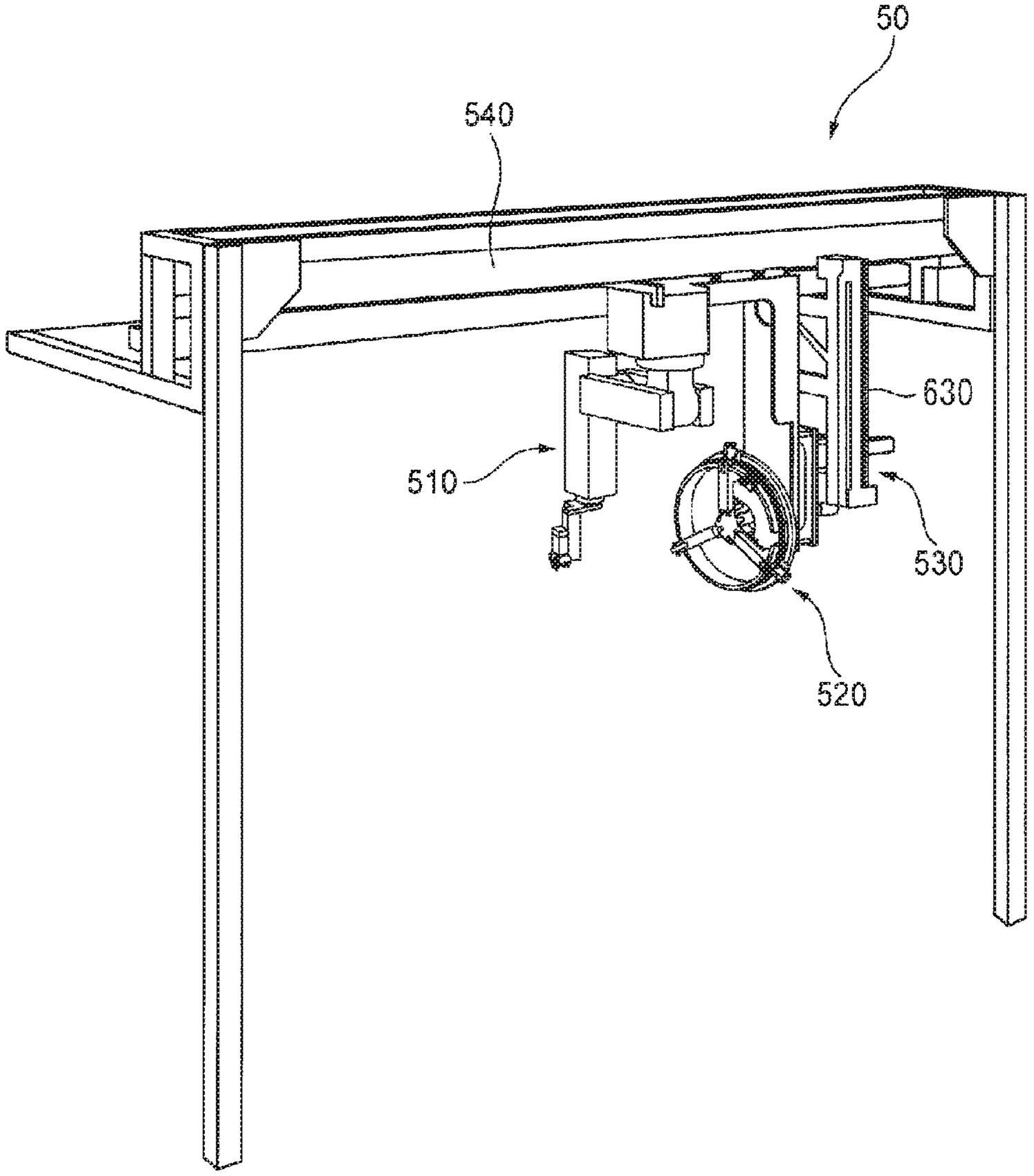


FIG. 6



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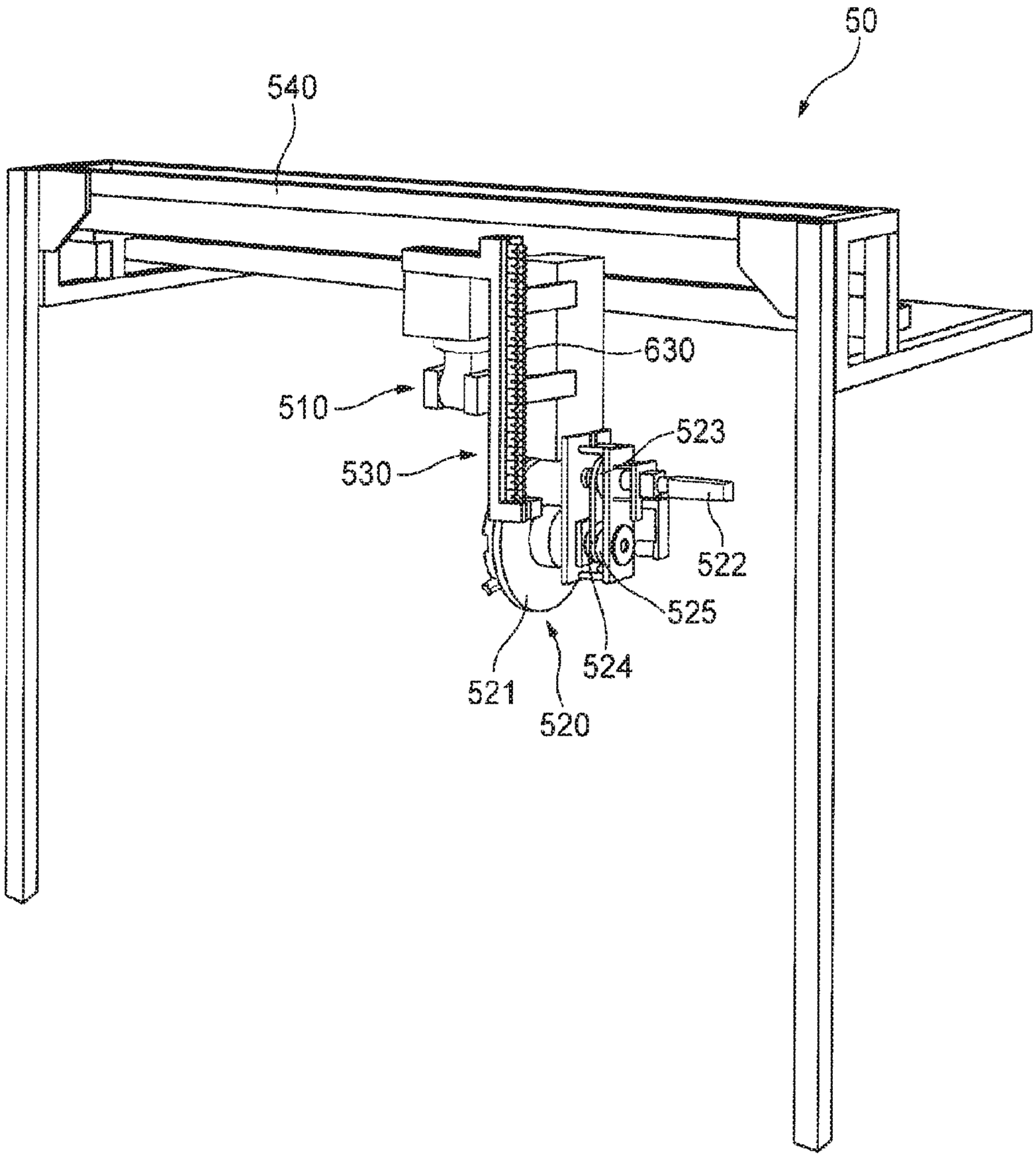

FIG. 8

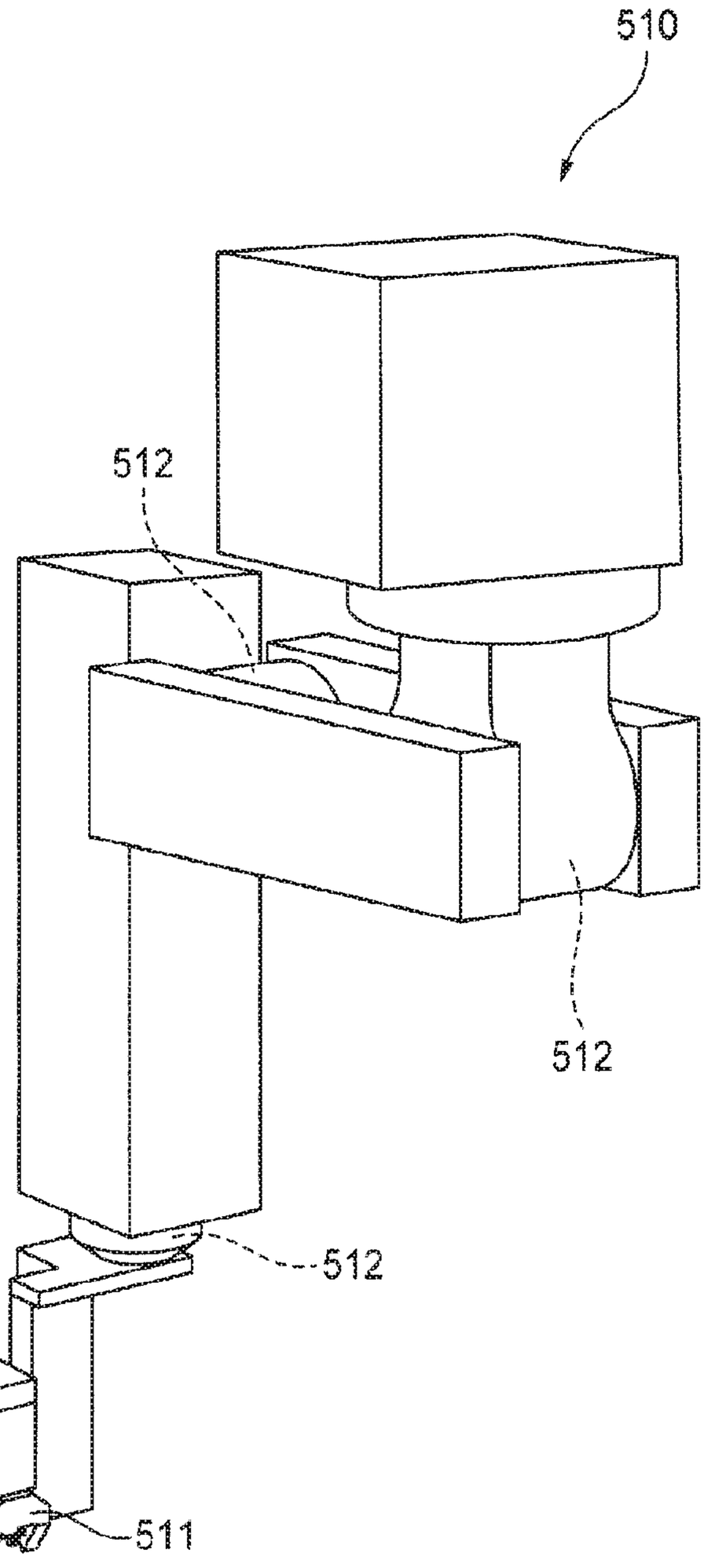

FIG. 9

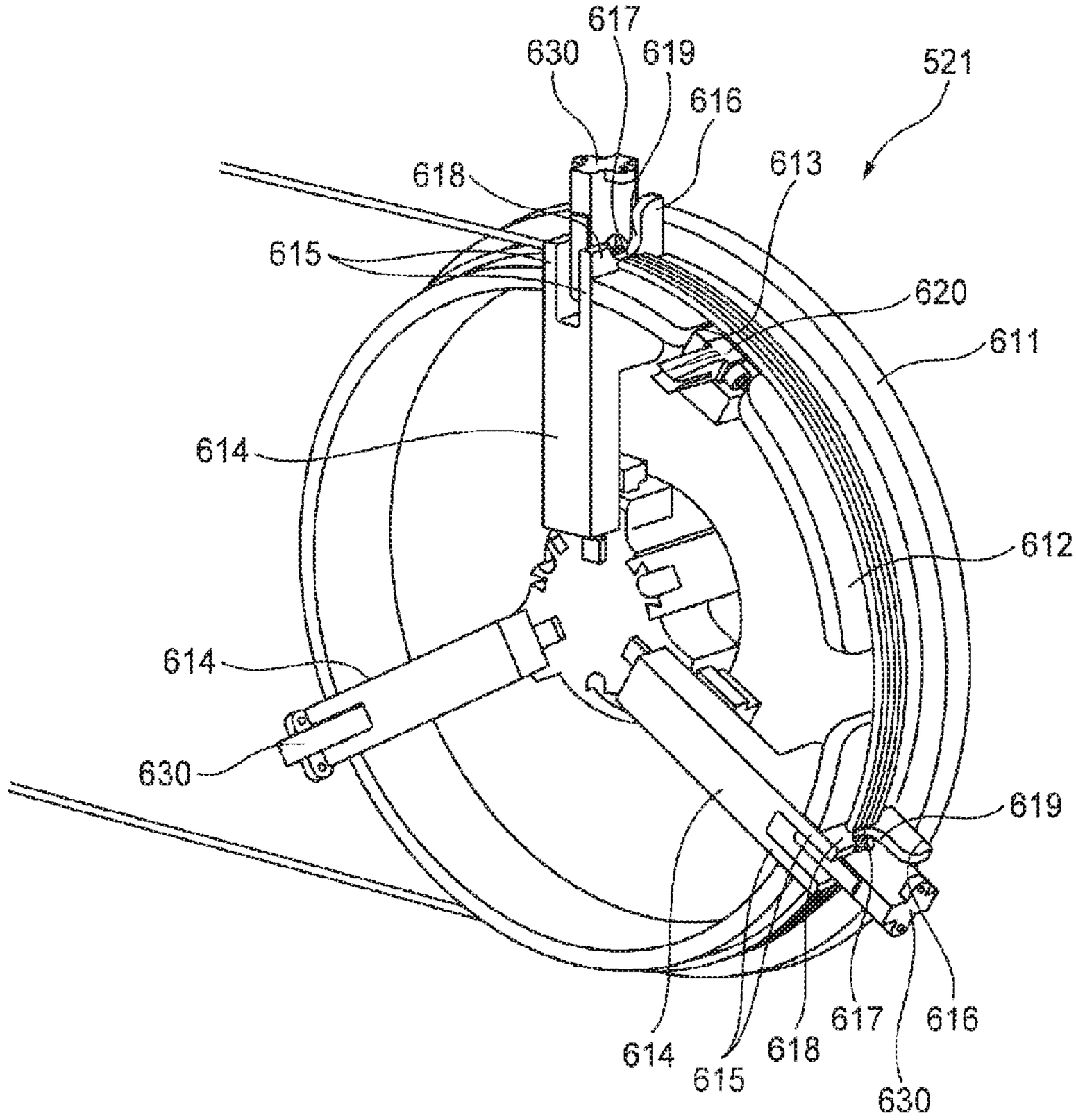
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FIG. 10

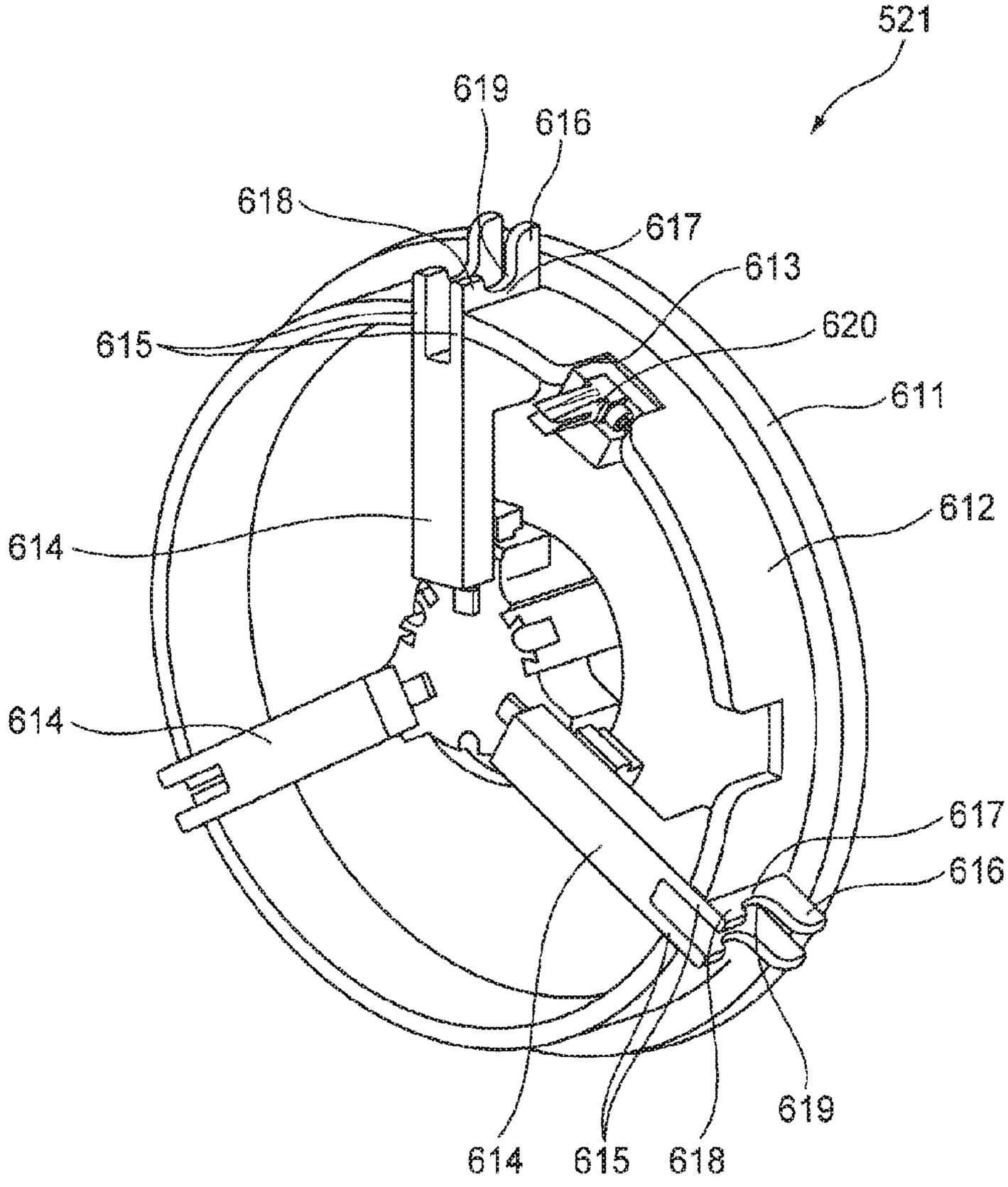
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FIG. 11

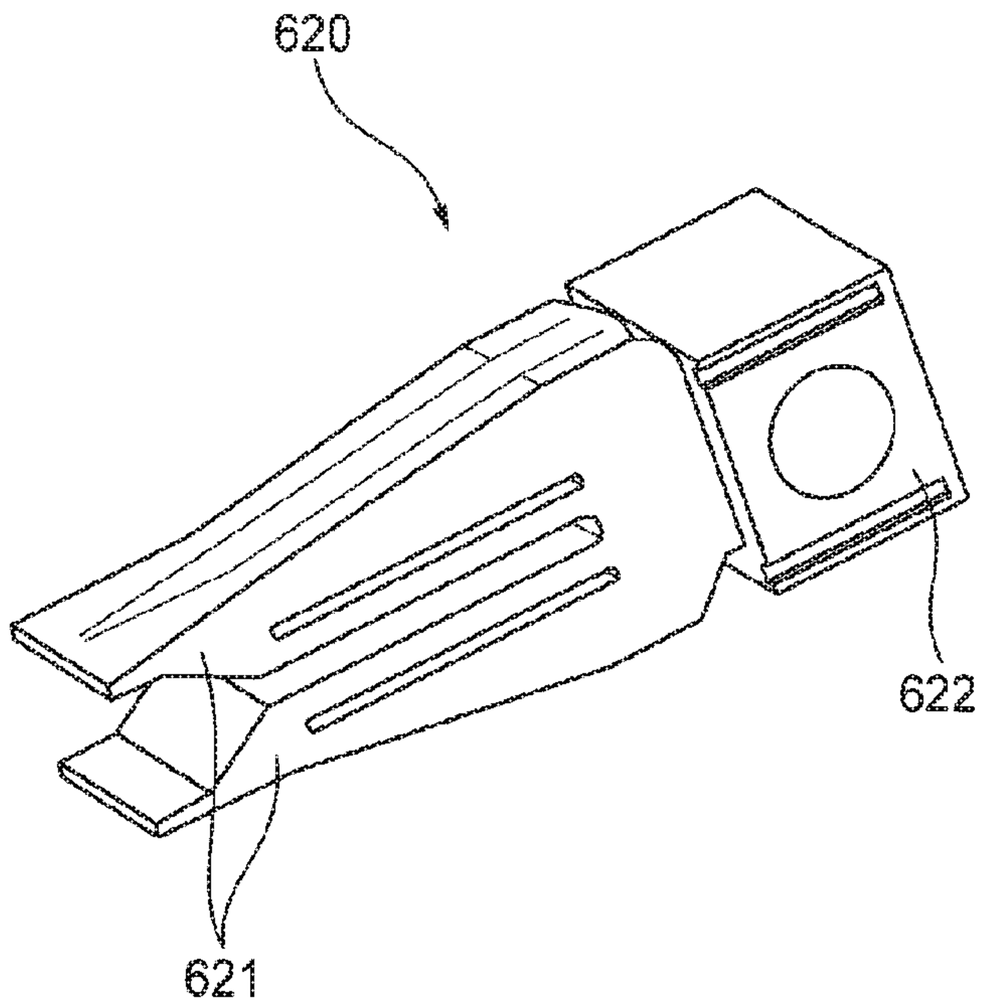


FIG. 12

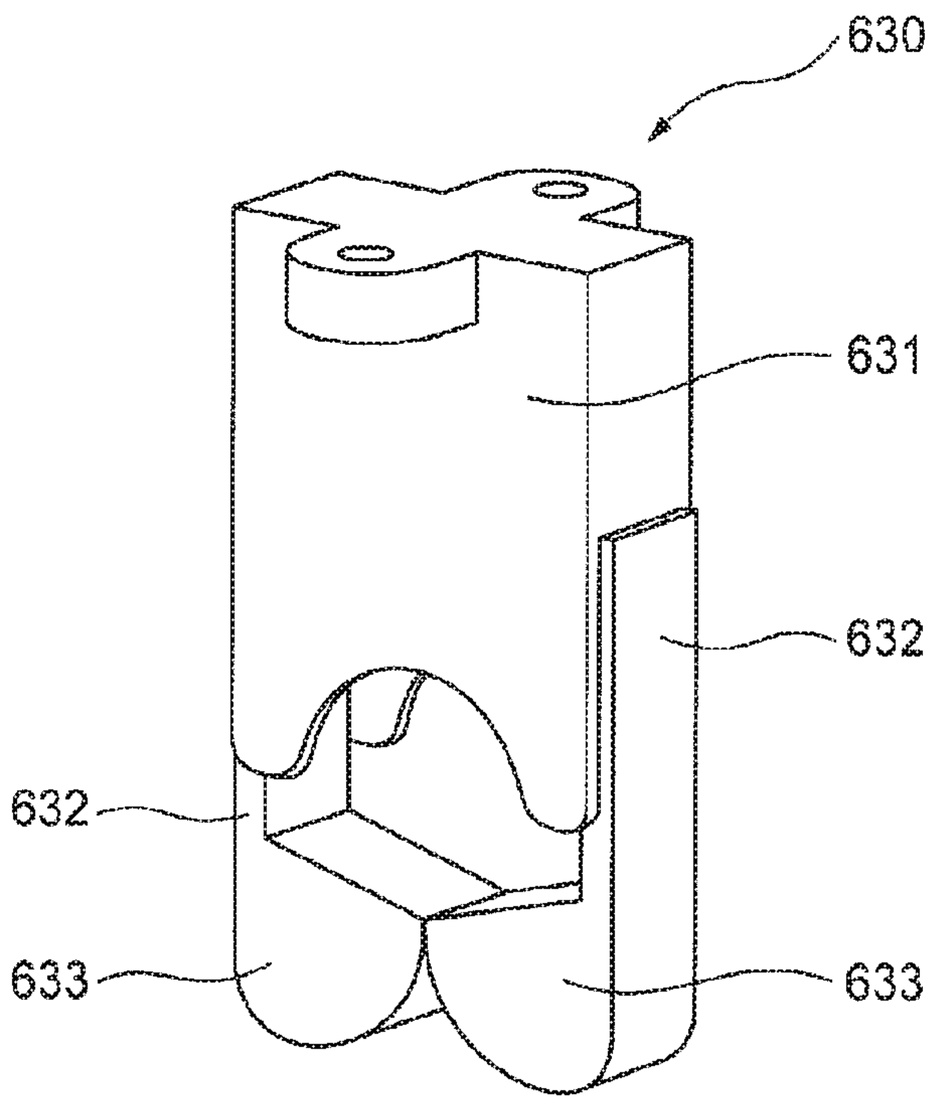


FIG. 13

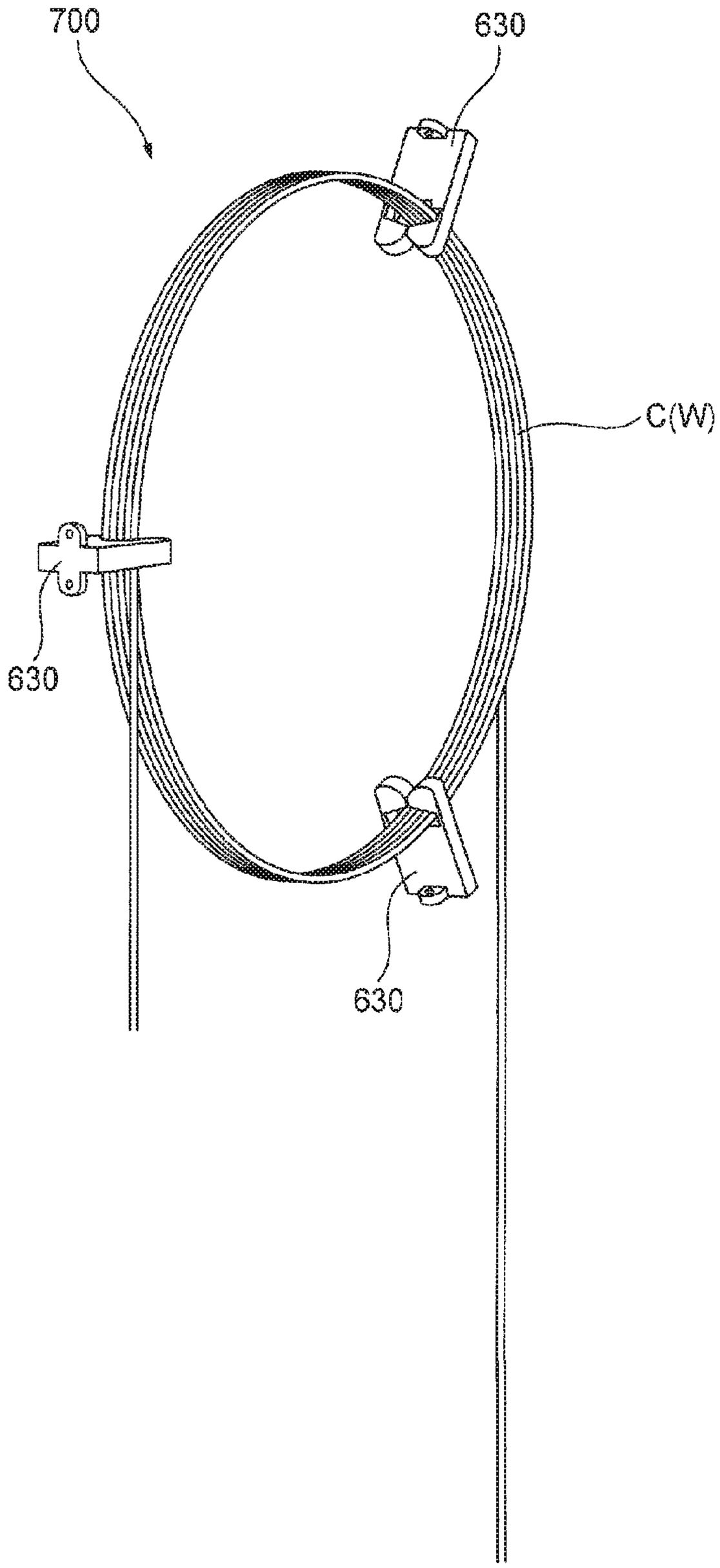


FIG. 14A

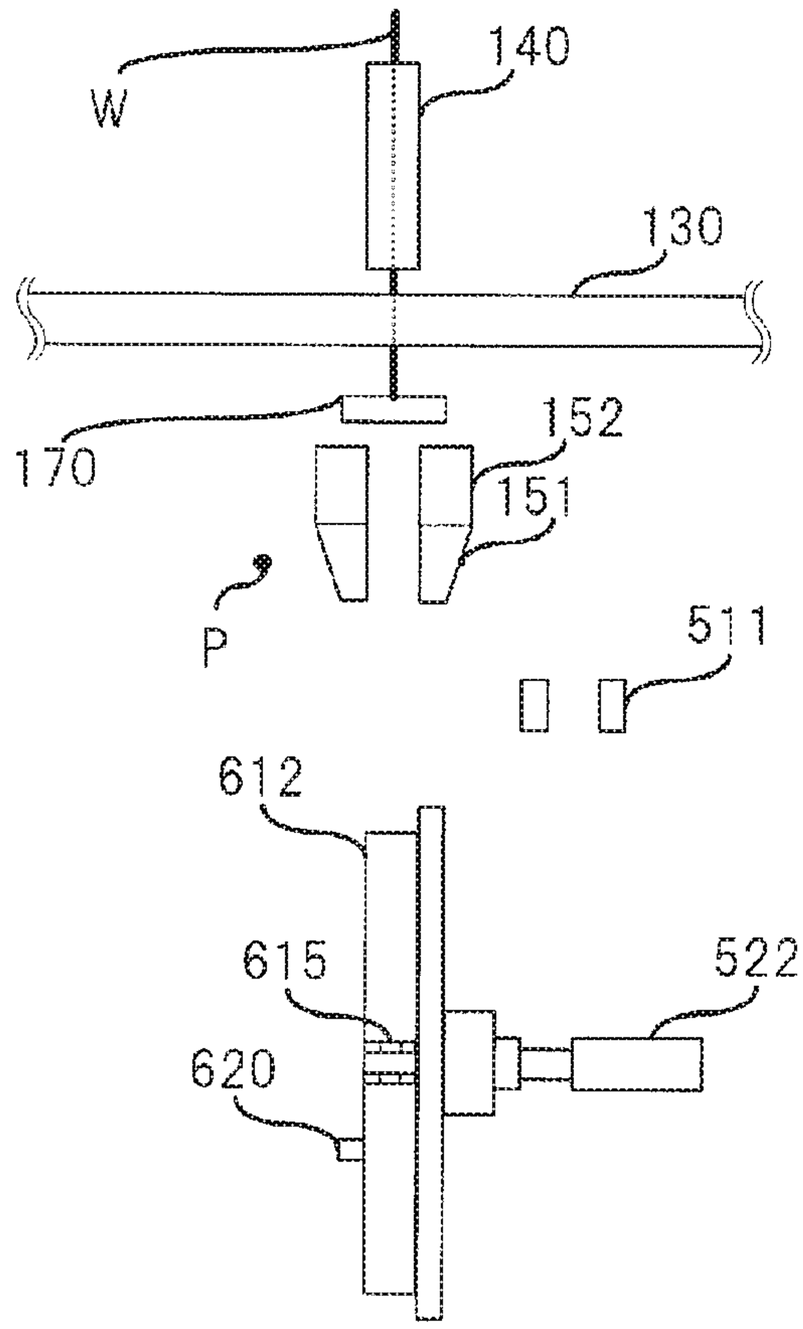
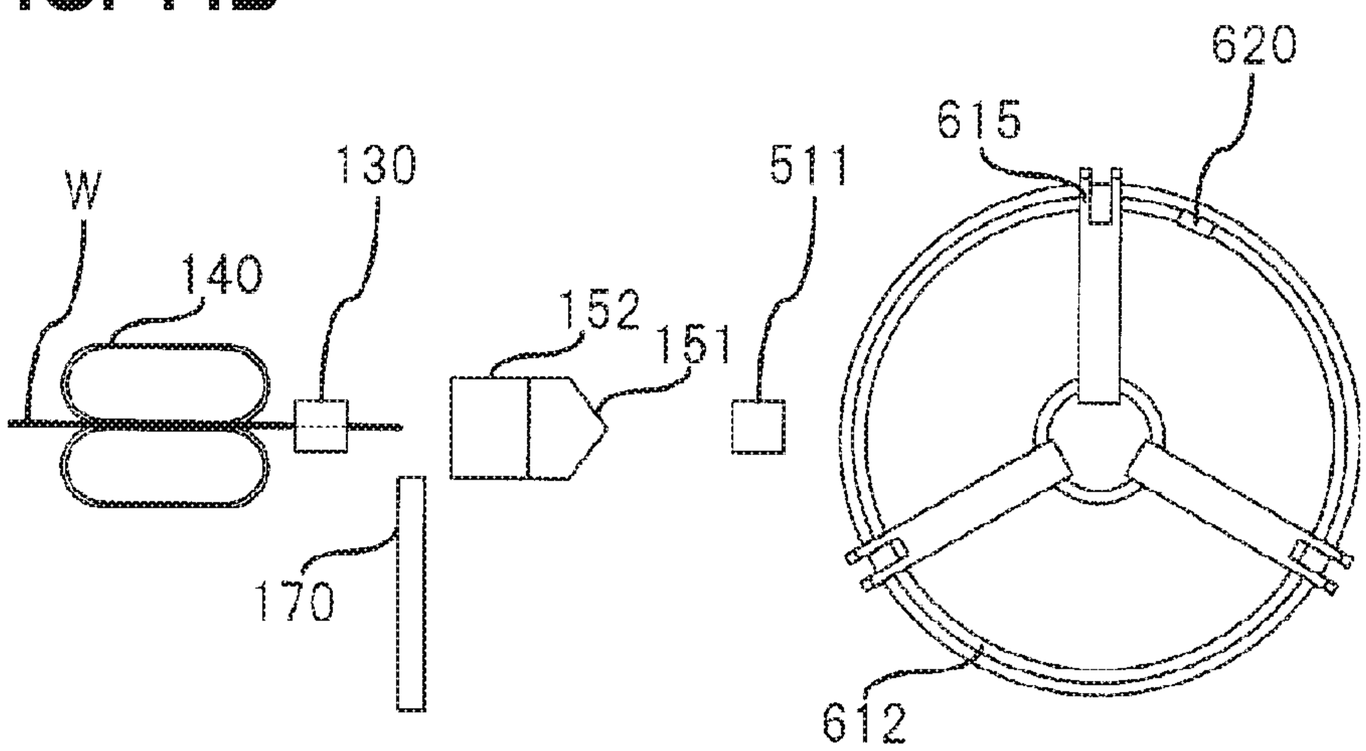


FIG. 14B



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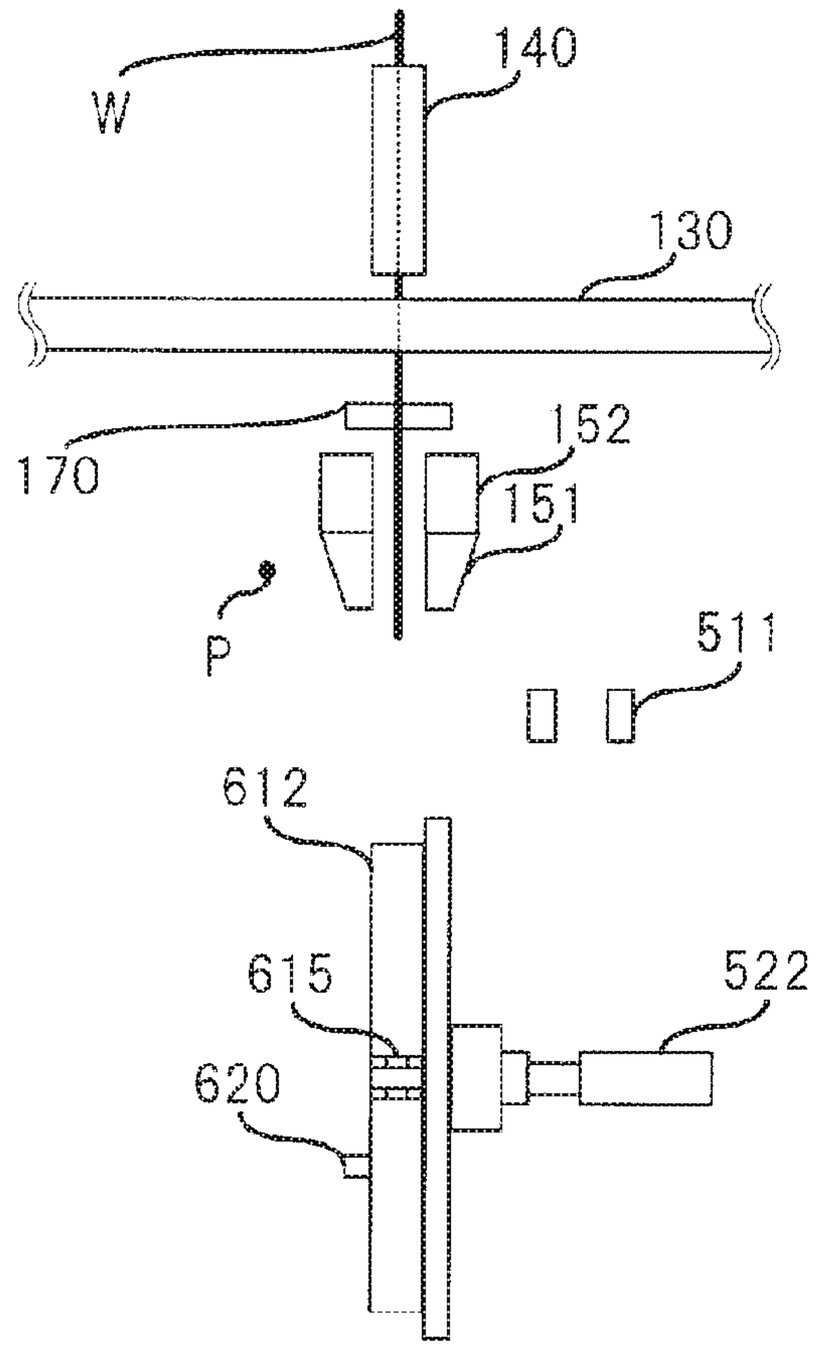
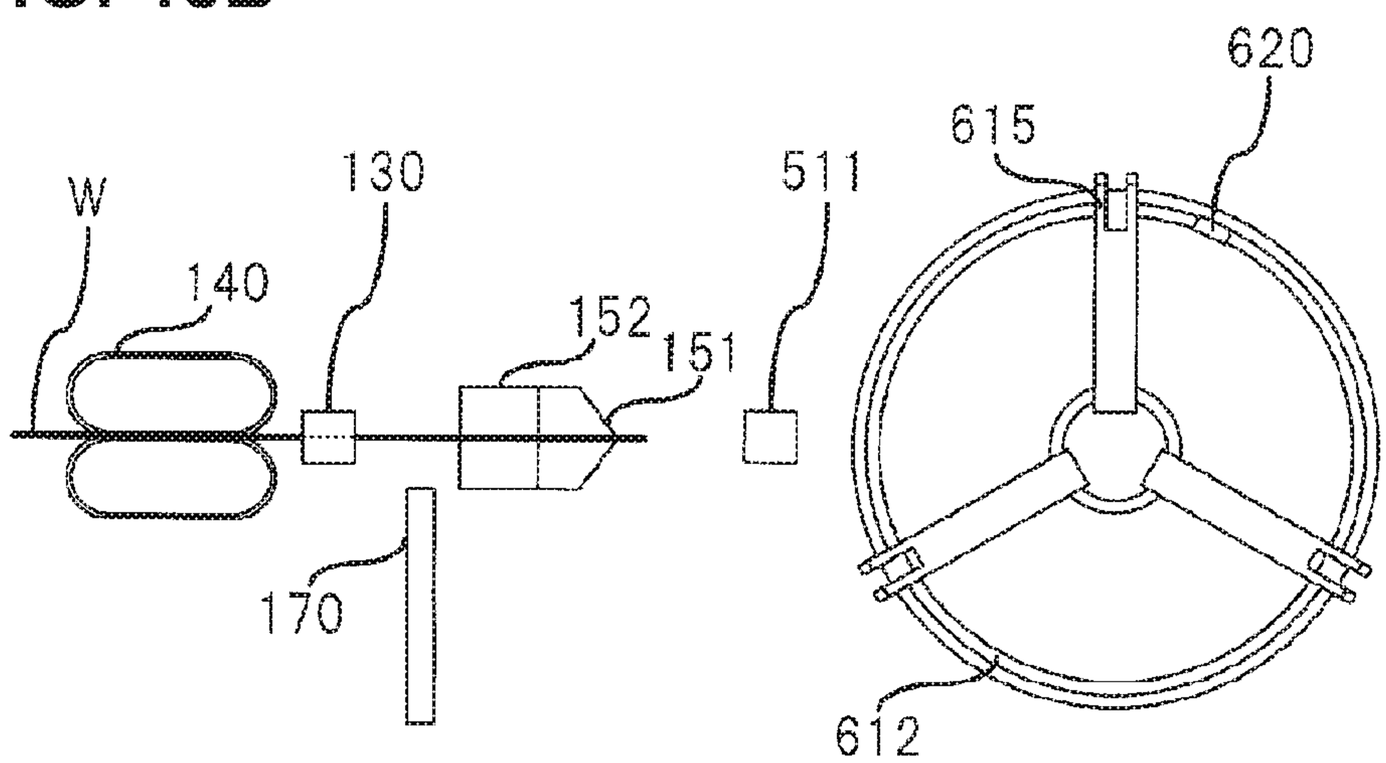


FIG. 15B



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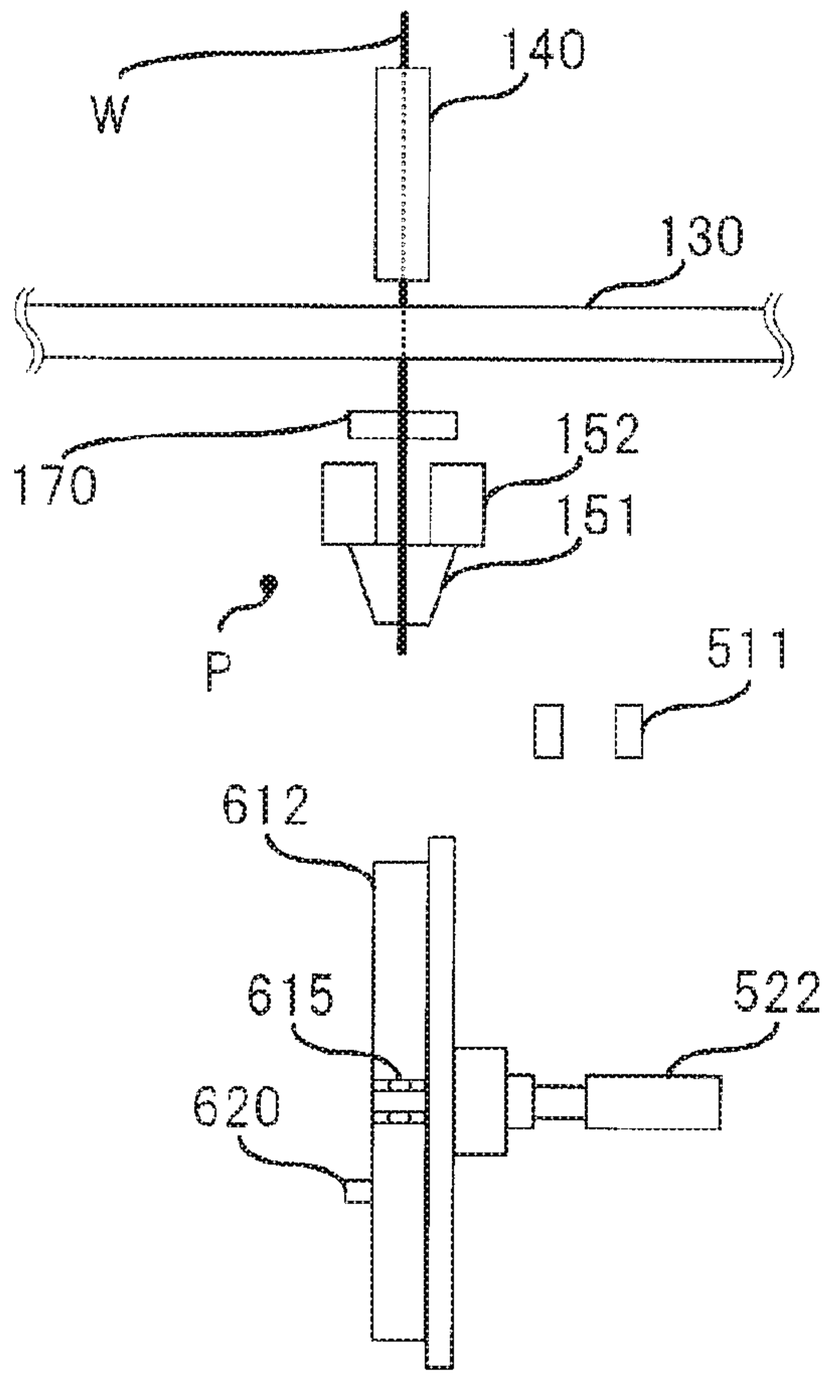
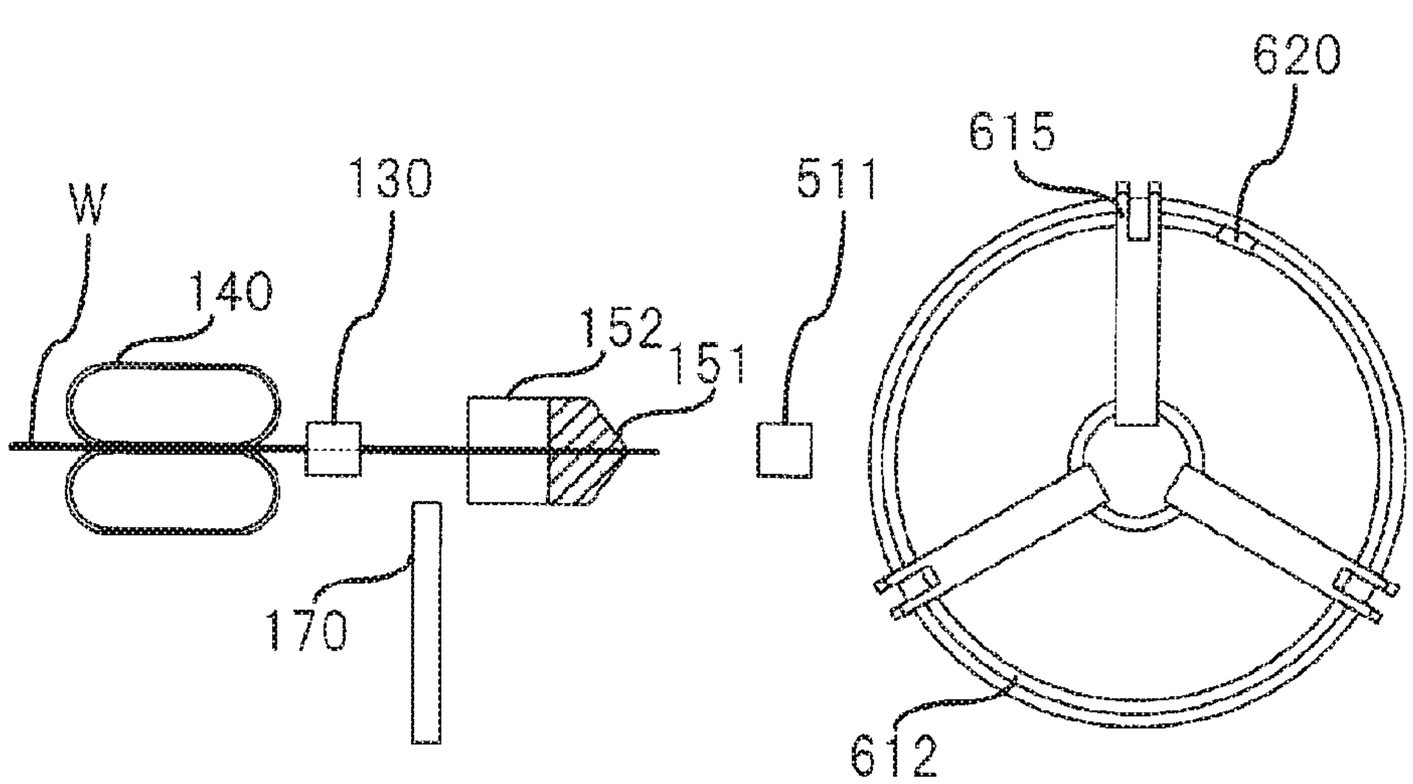


FIG. 16B



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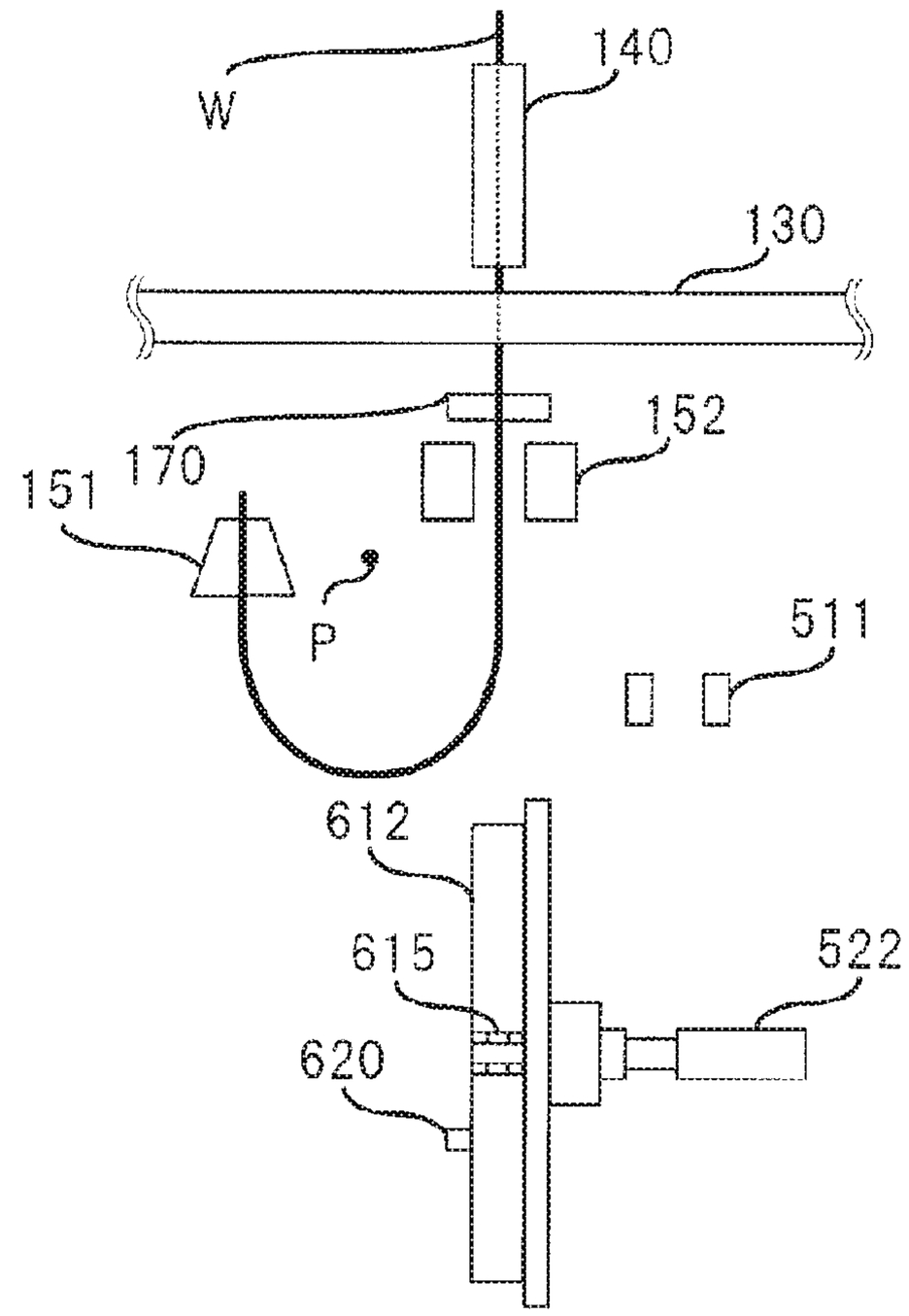


FIG. 17B

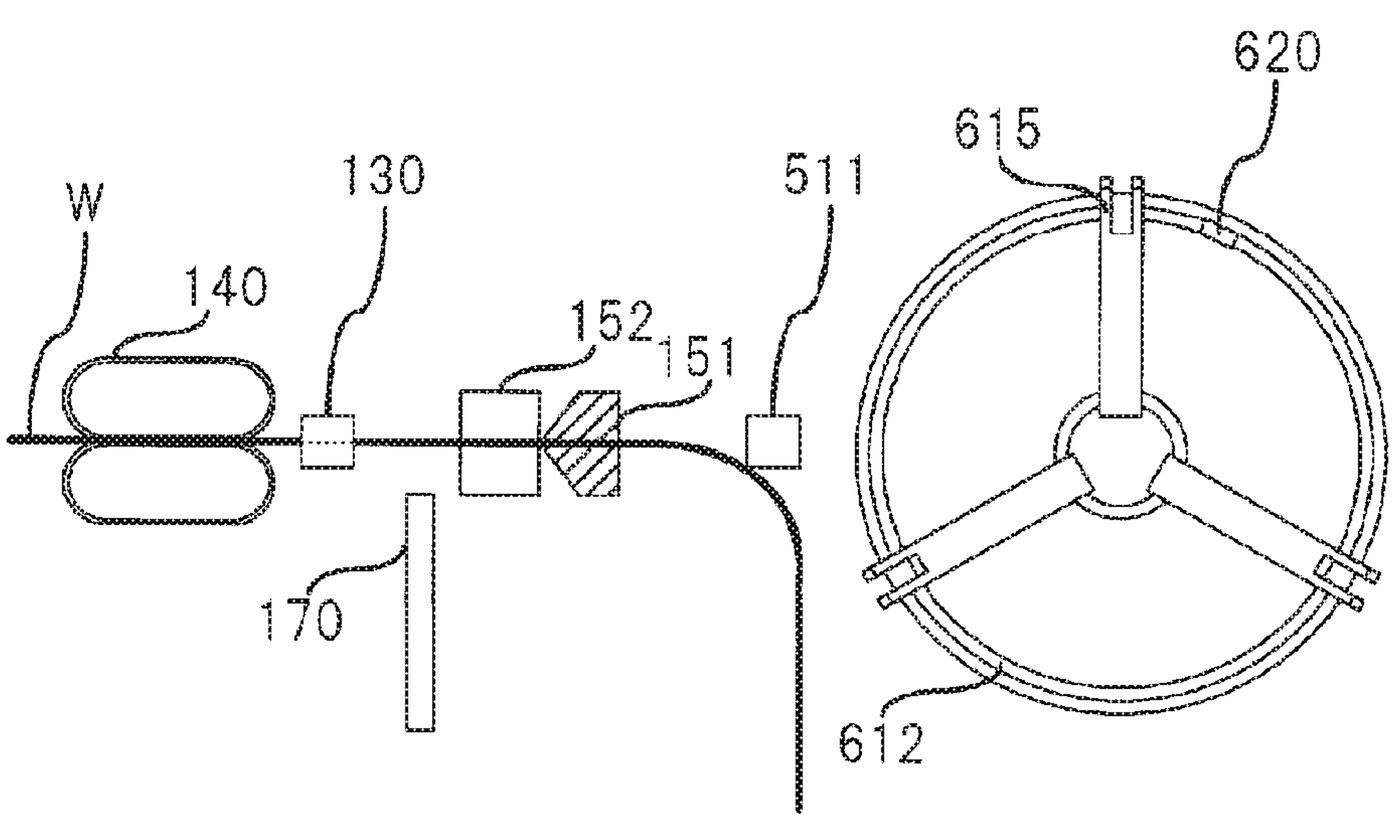


FIG. 18A

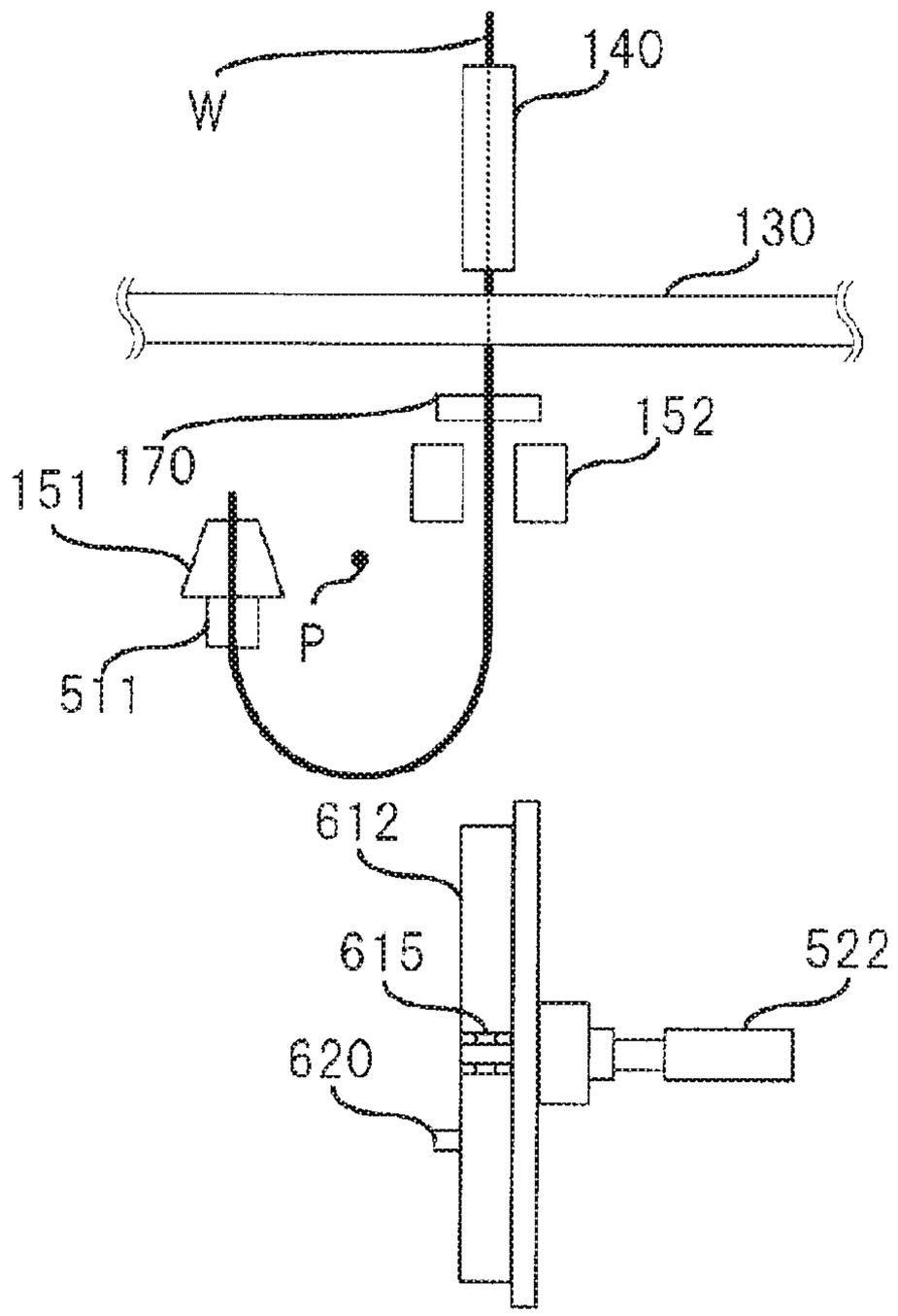
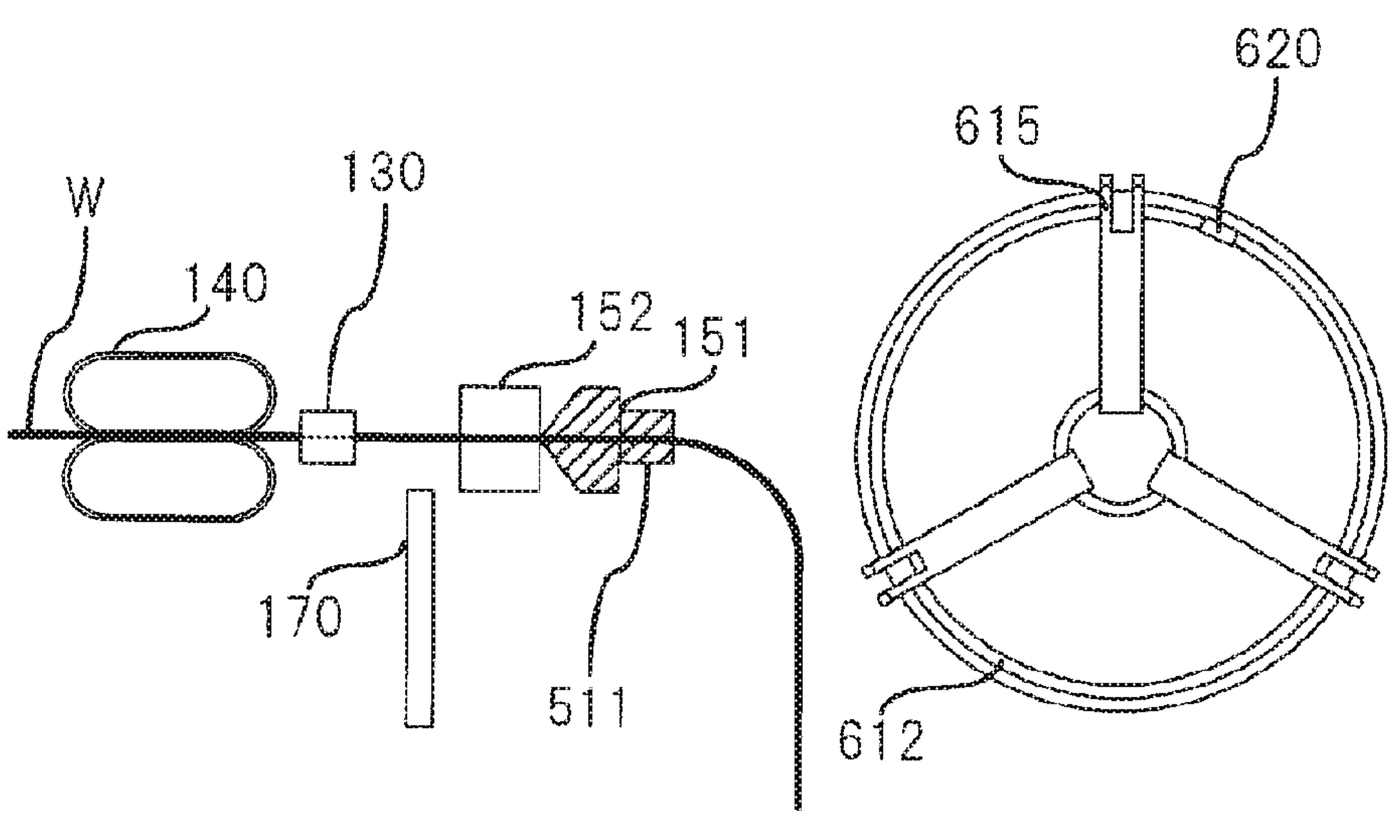


FIG. 18B



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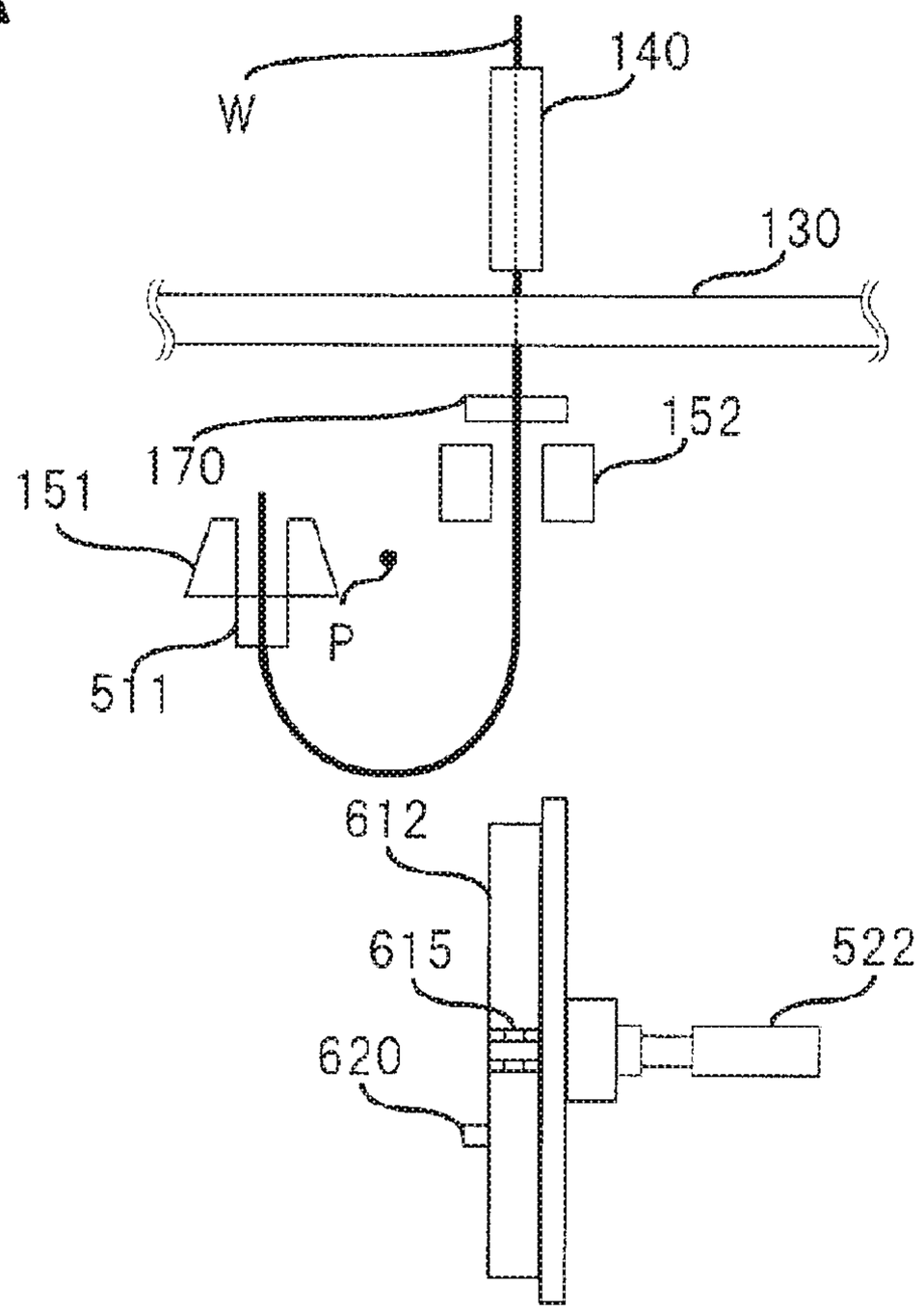
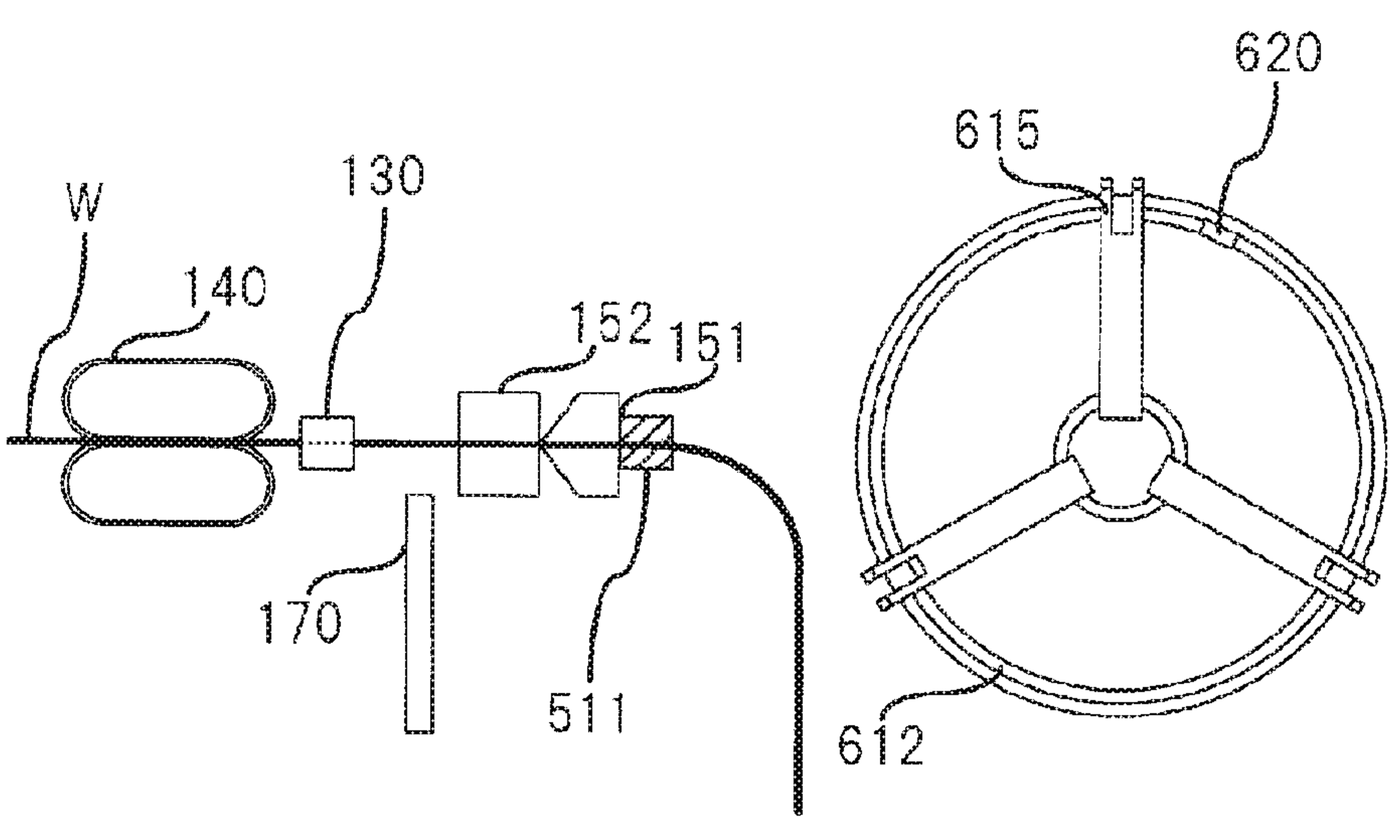


FIG. 19B



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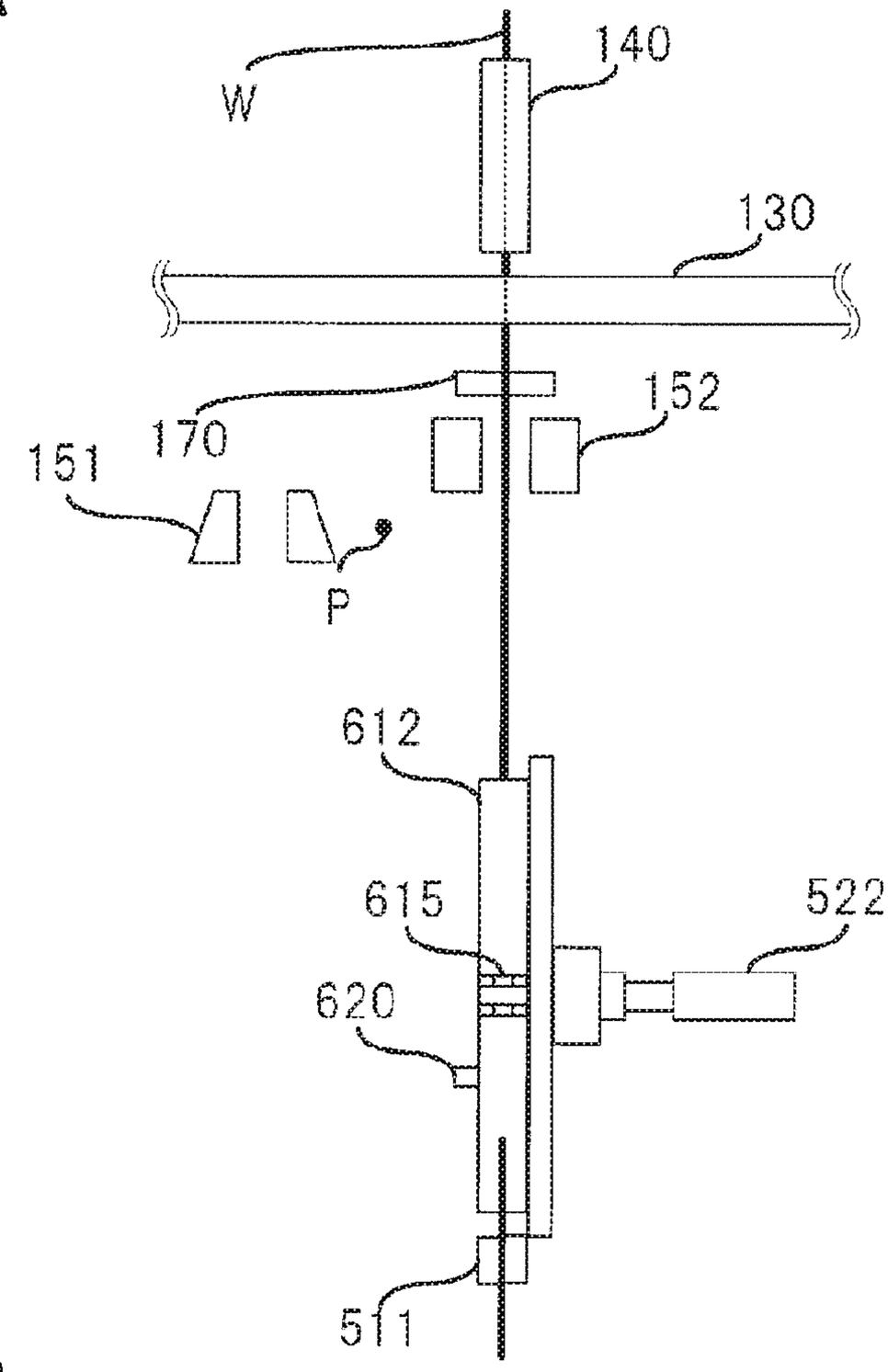


FIG. 20B

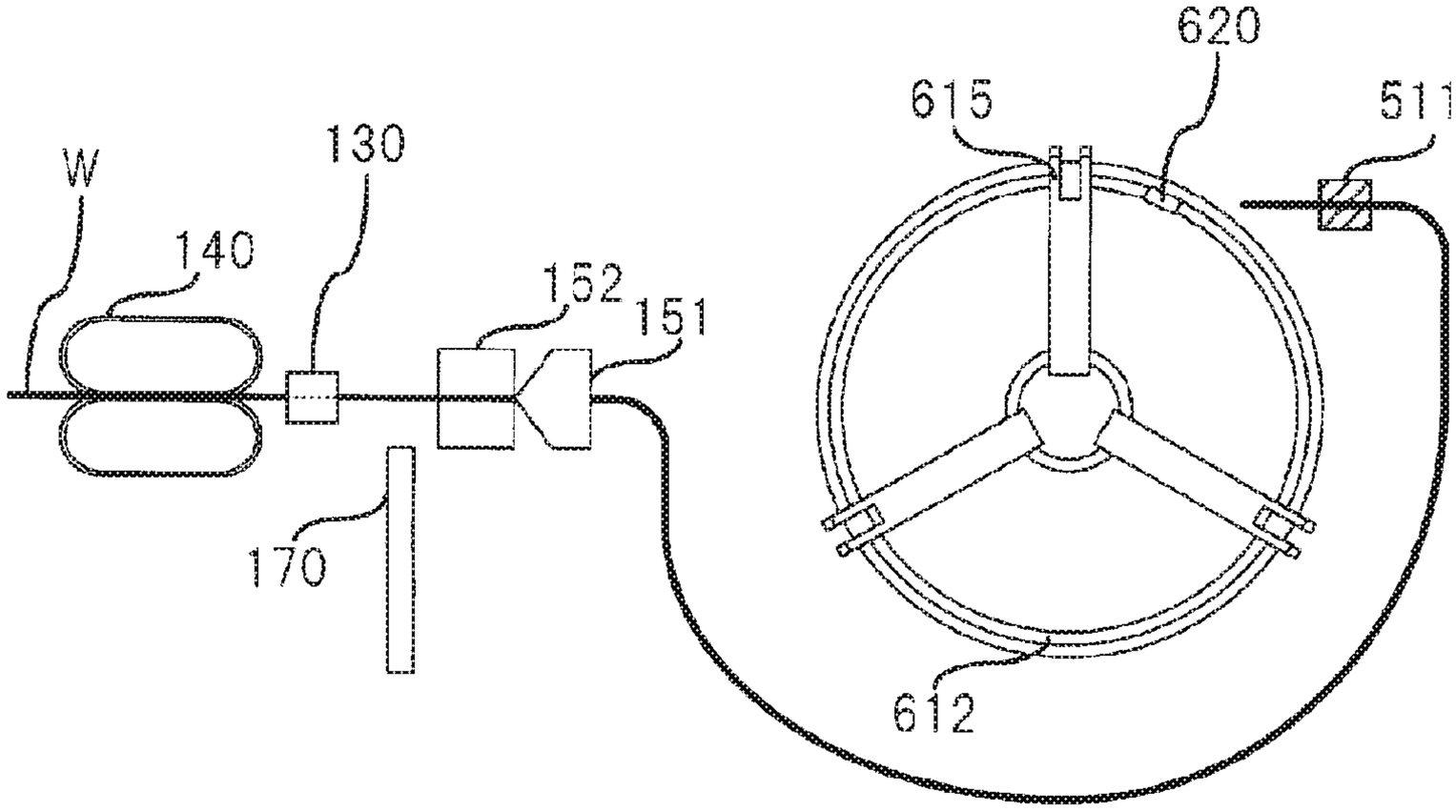


FIG. 21A

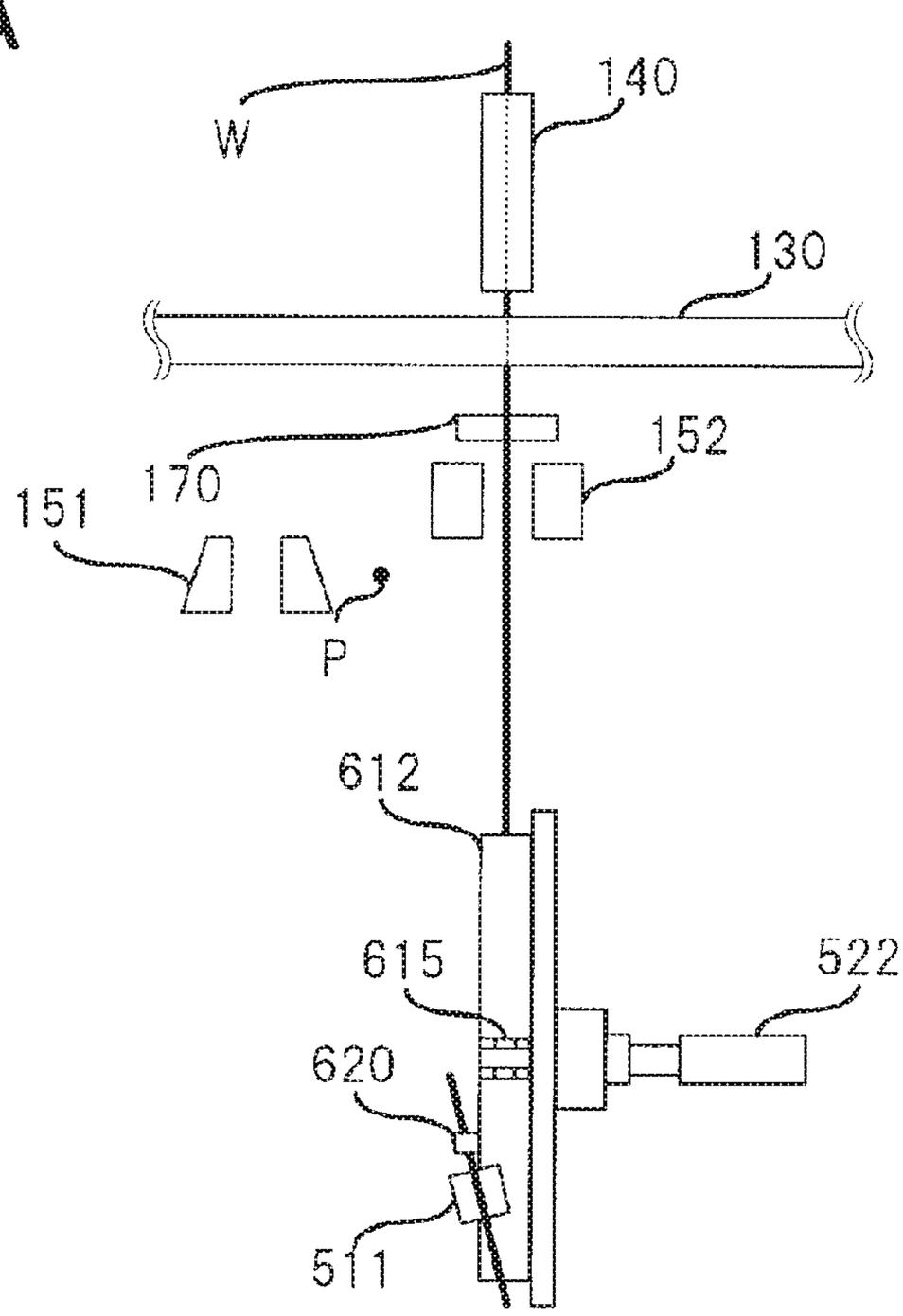
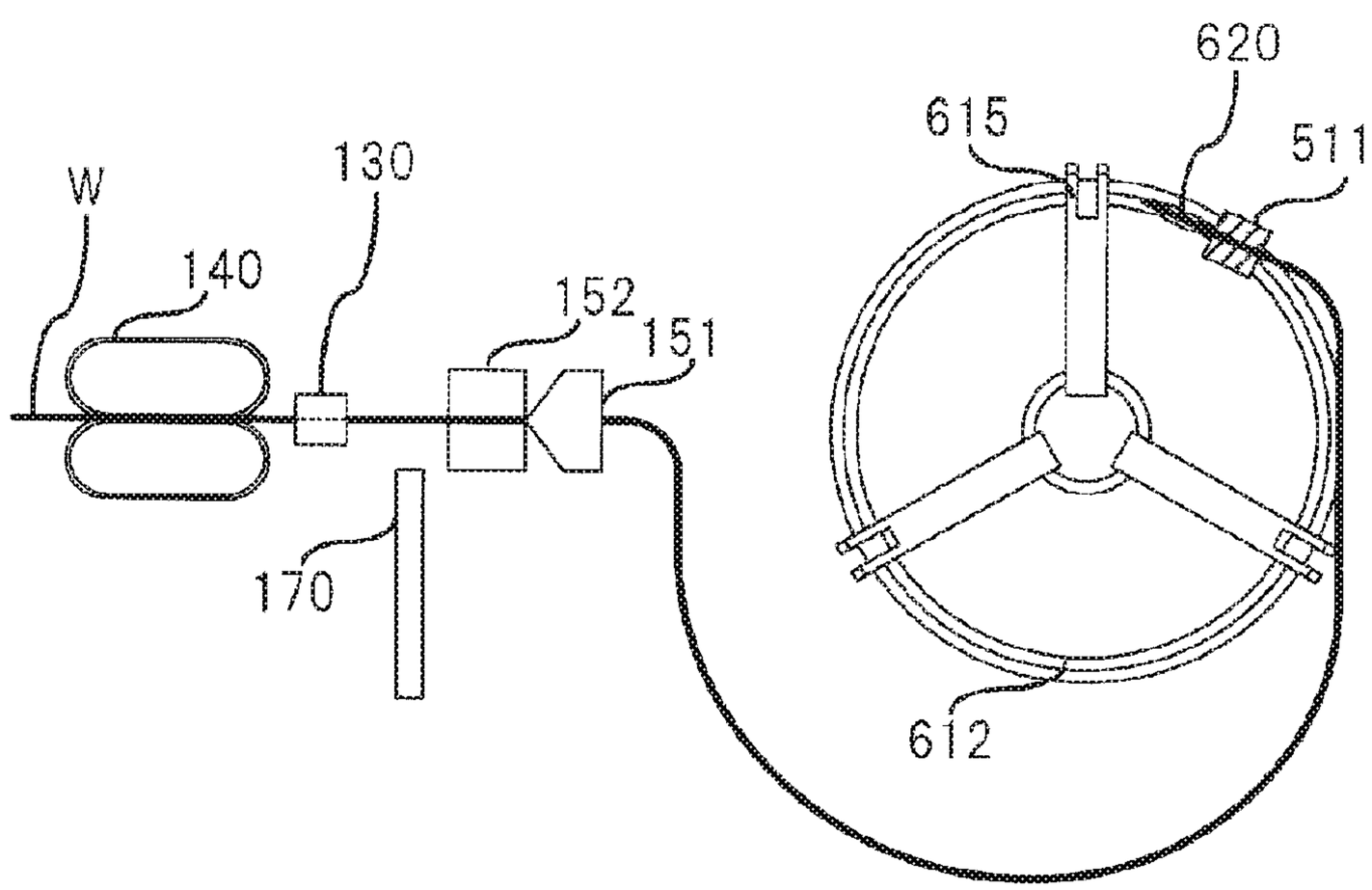


FIG. 21B



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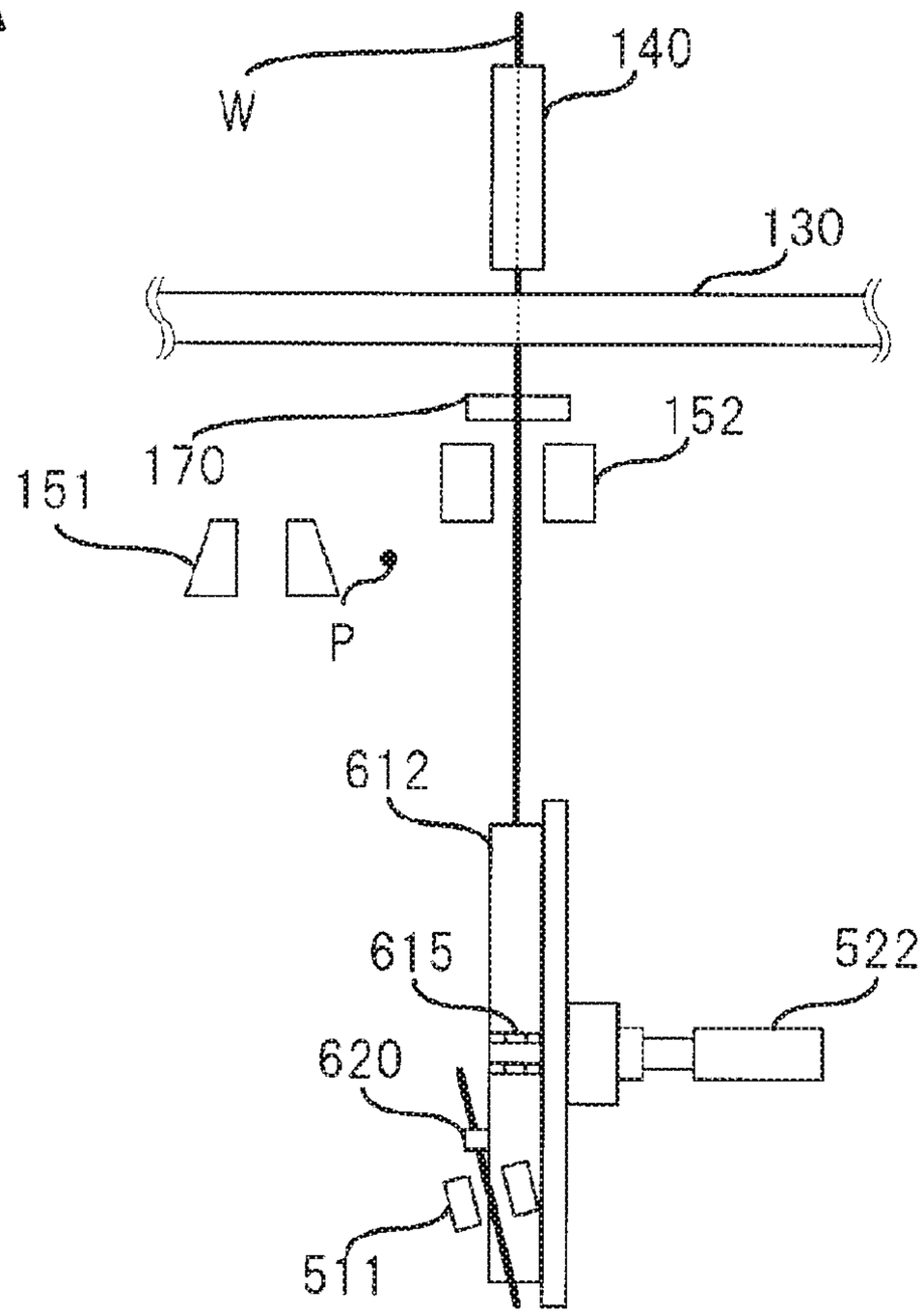
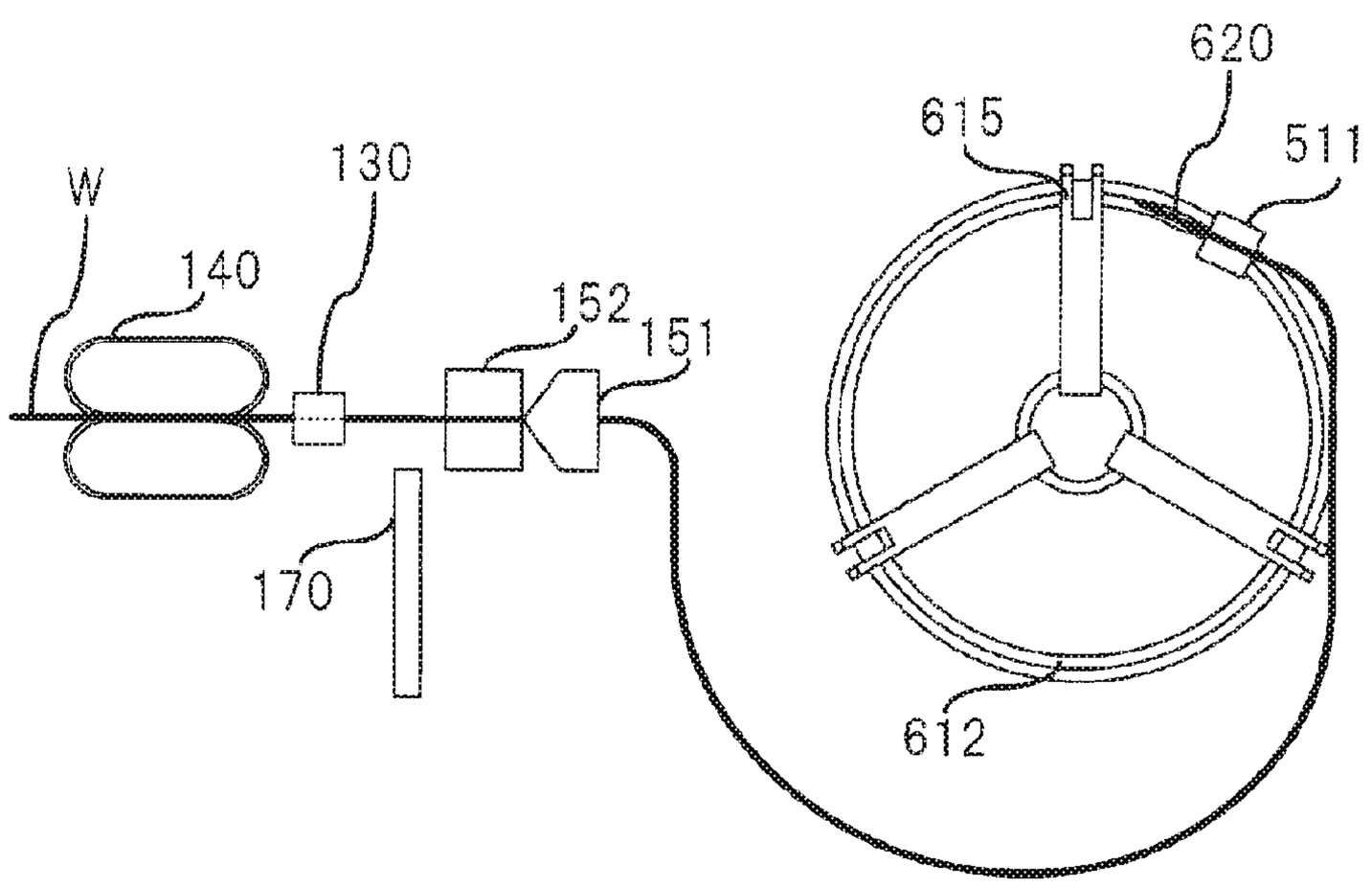


FIG. 22B



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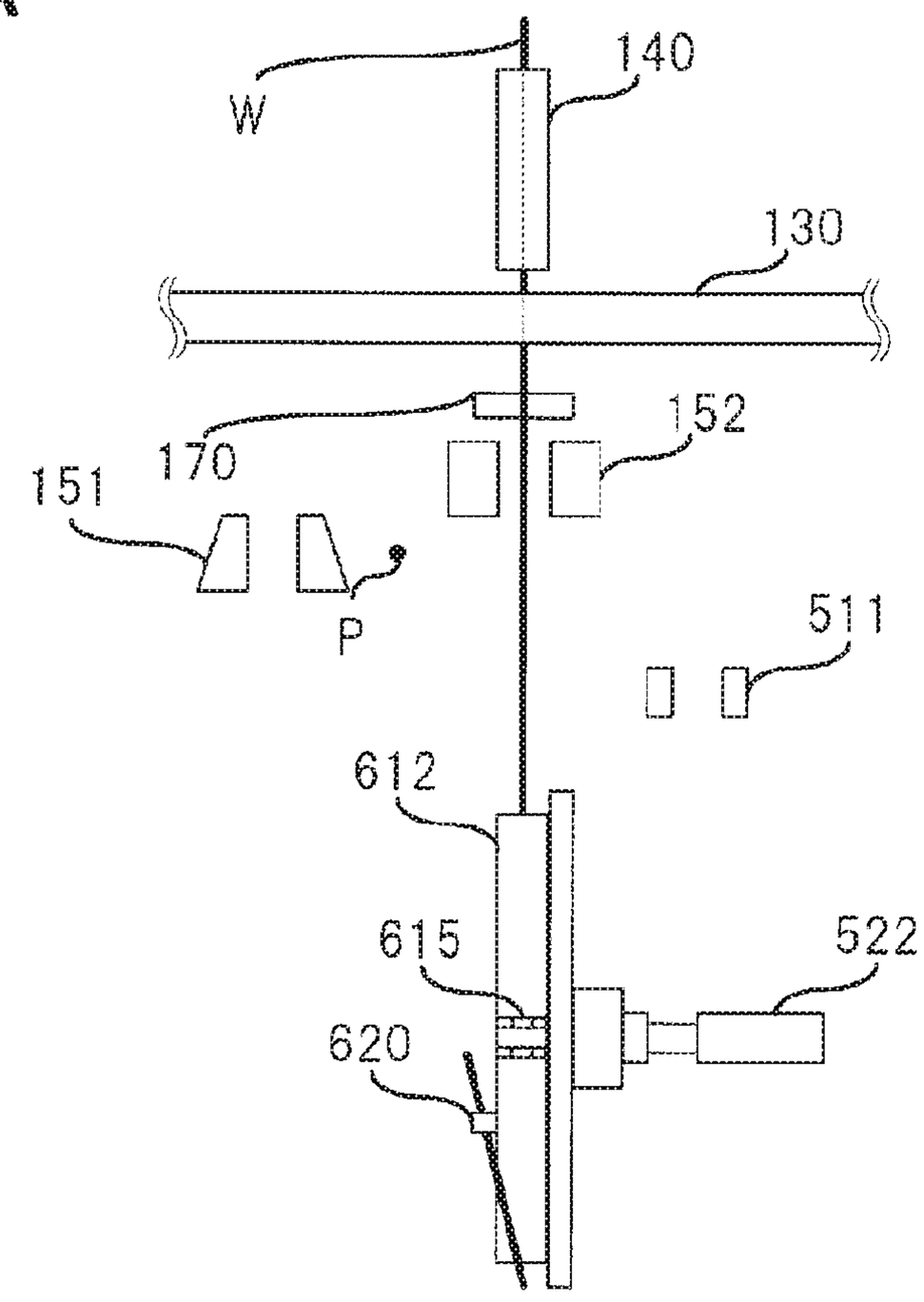

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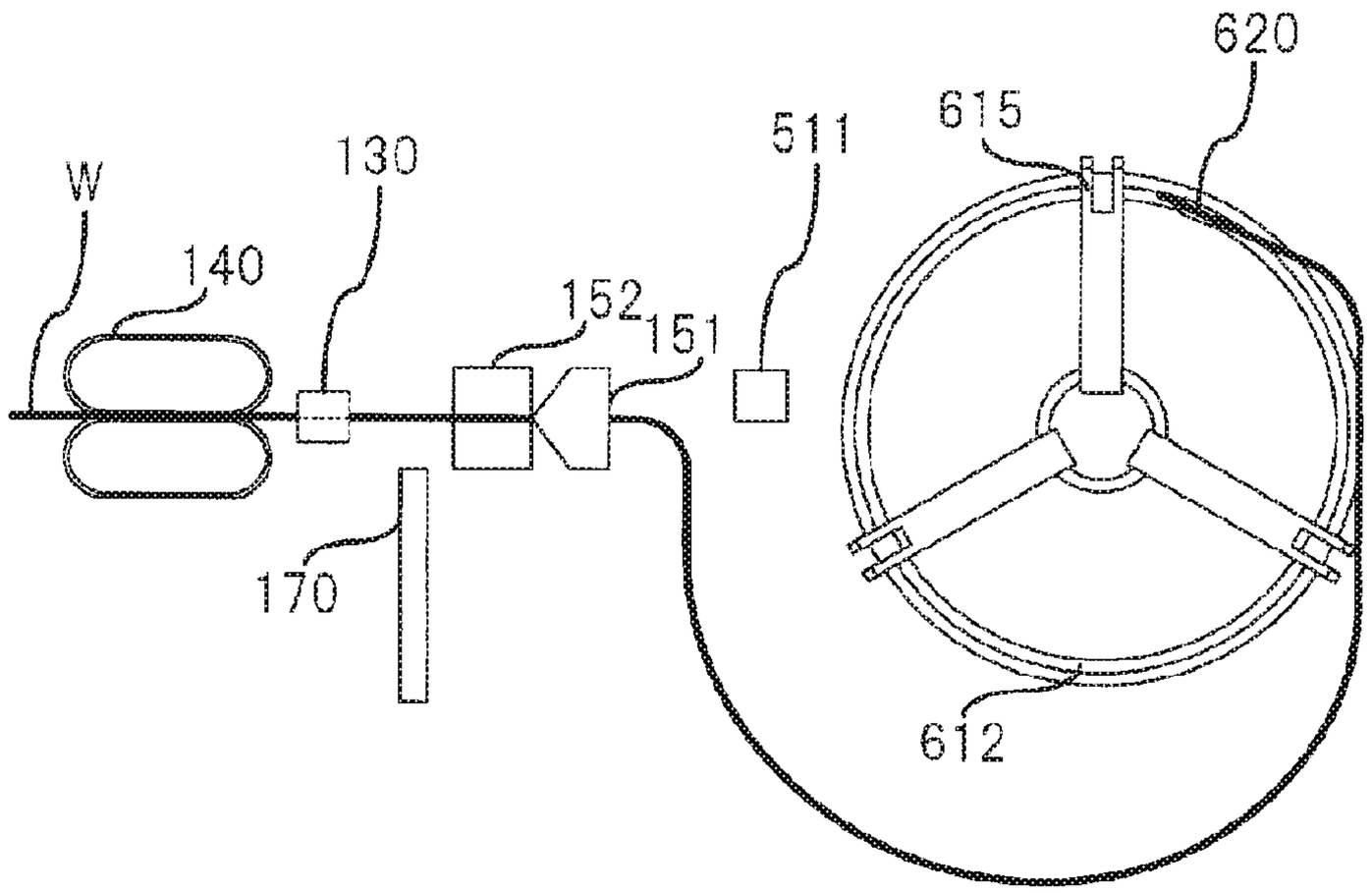

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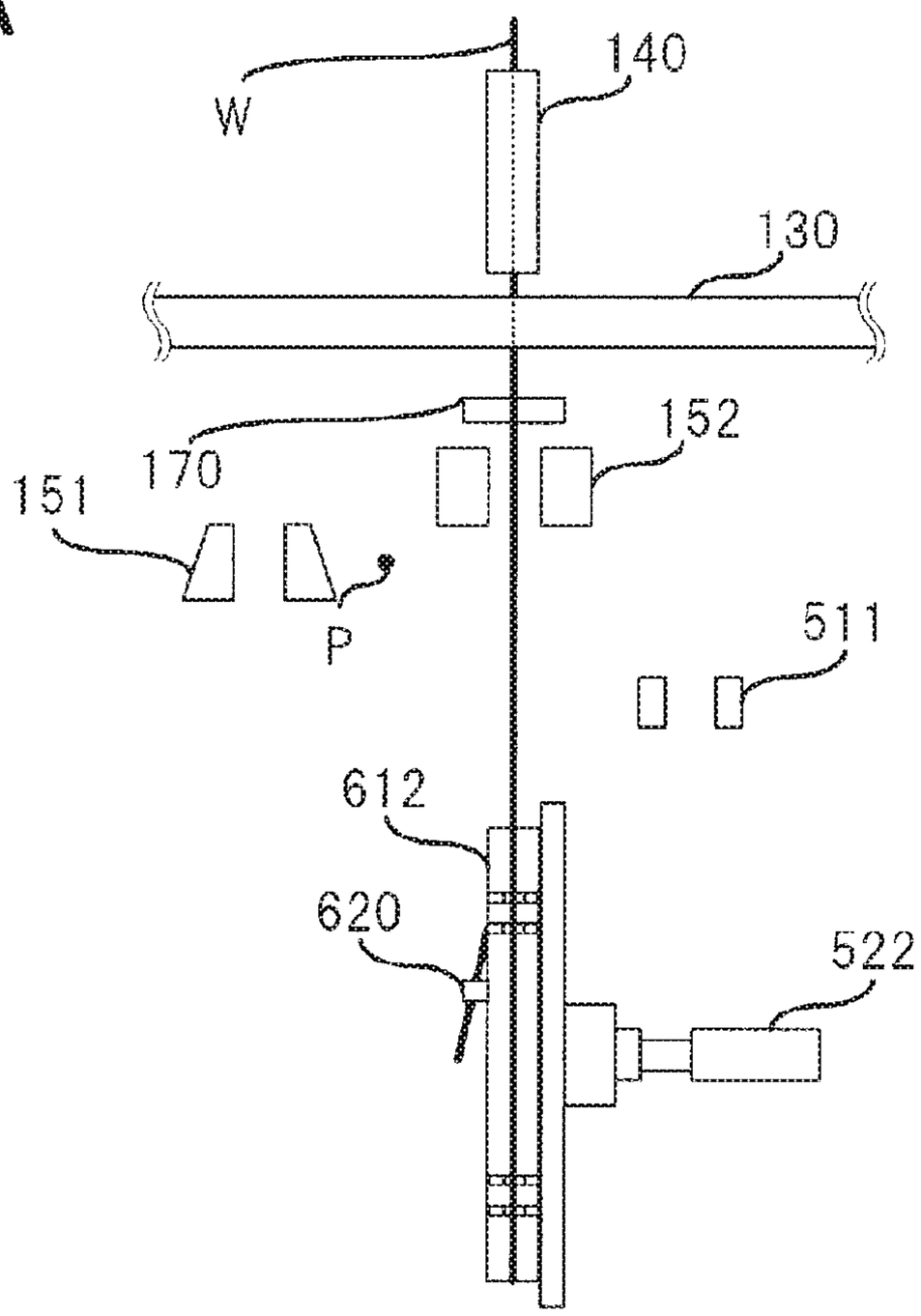


FIG. 24B

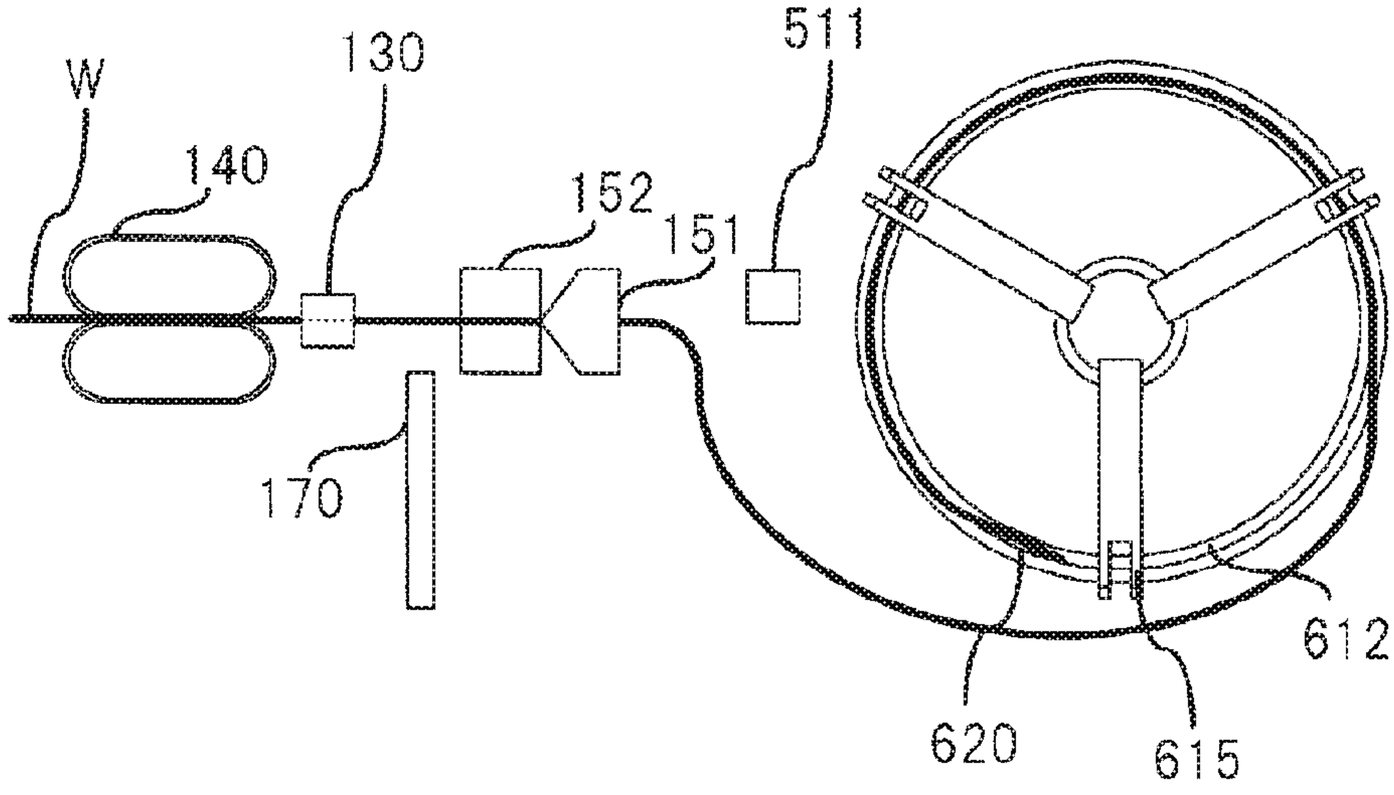
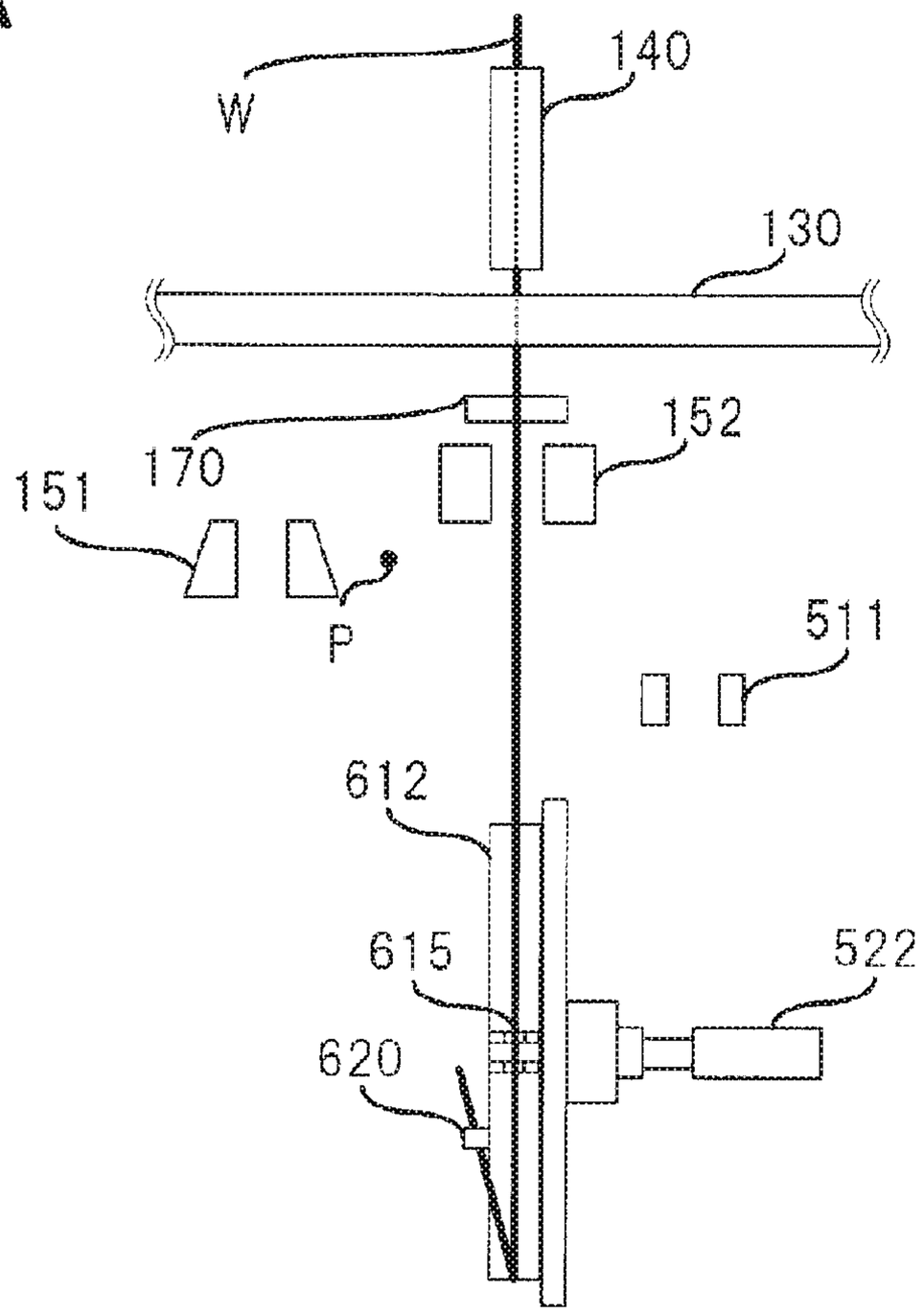


FIG. 25A



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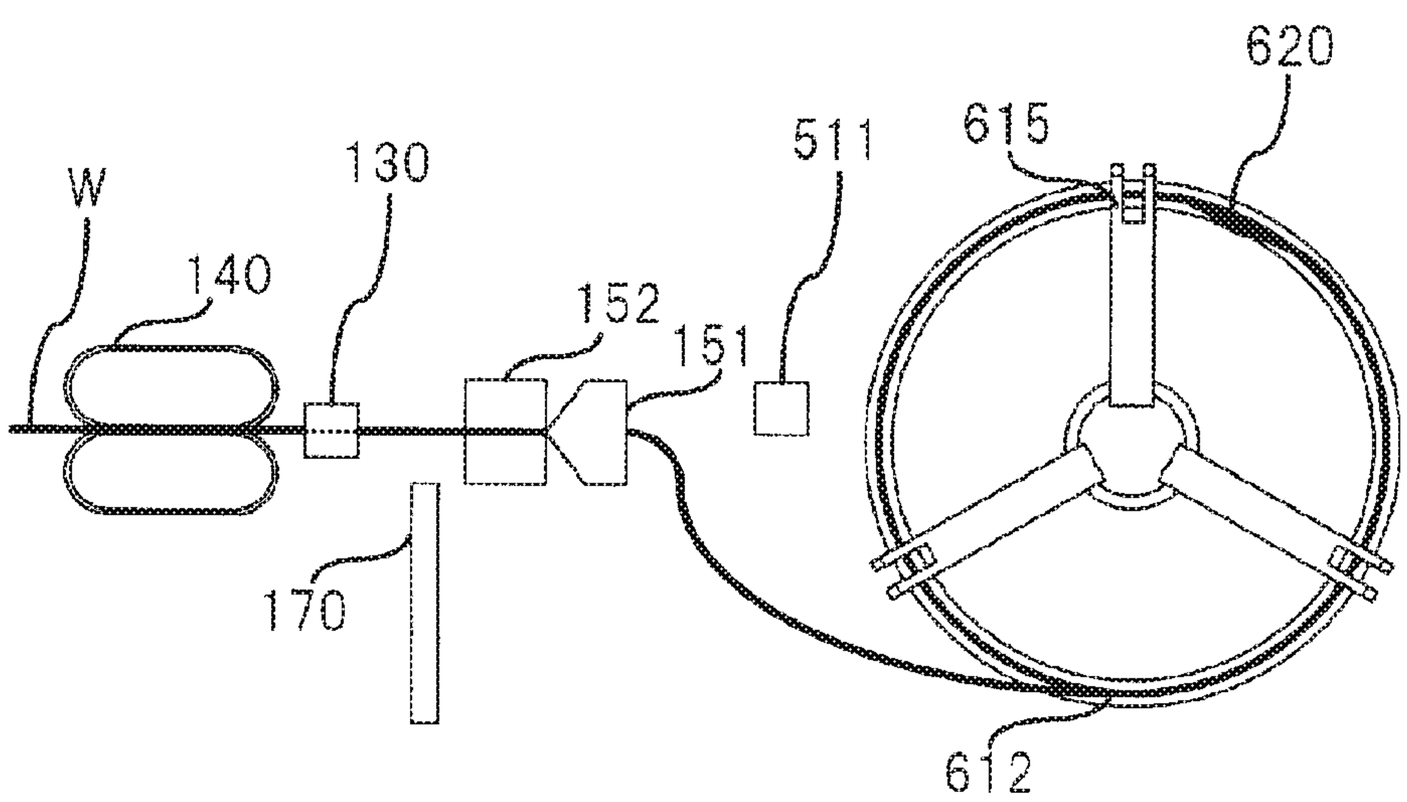


FIG. 26A

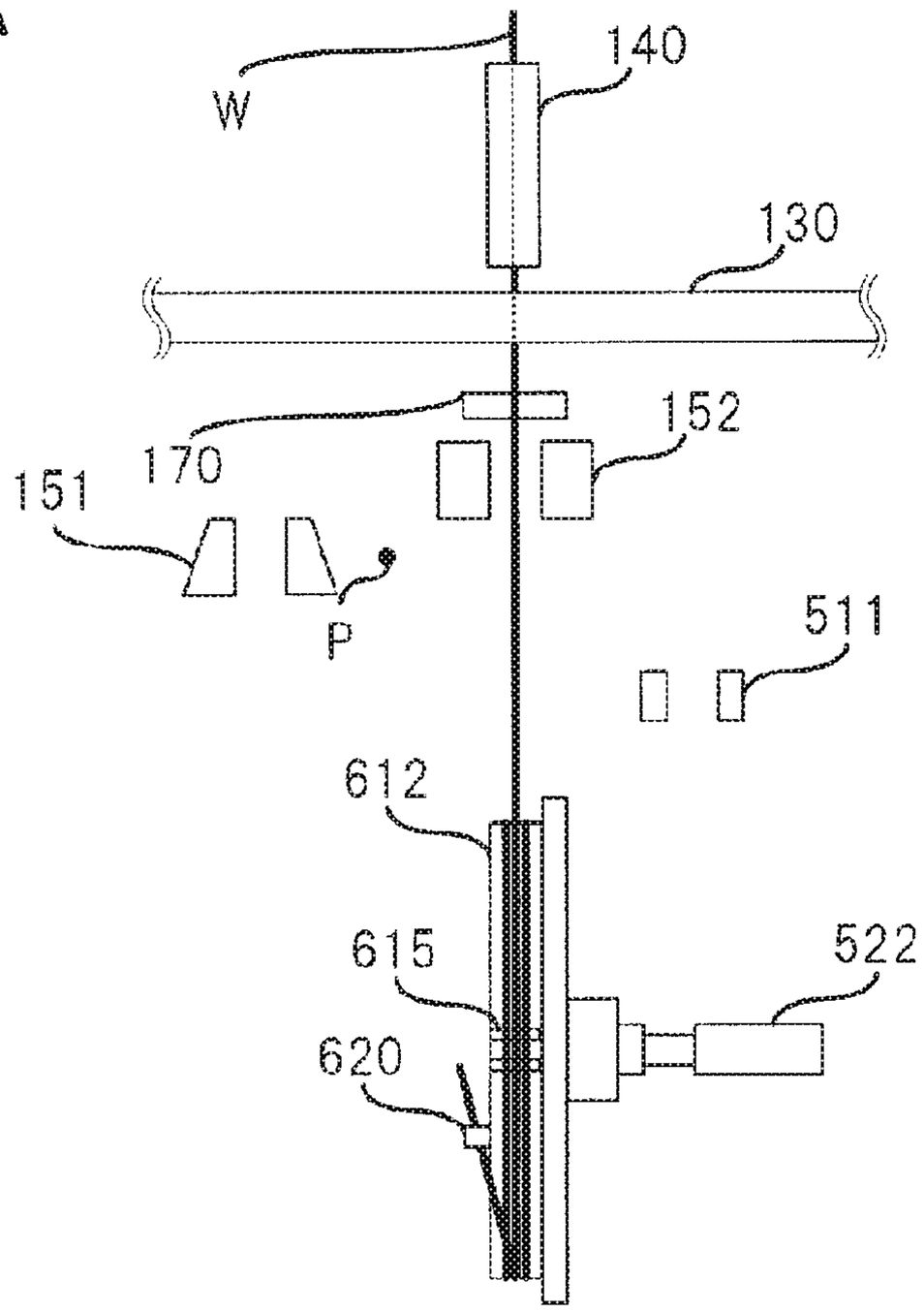


FIG. 26B

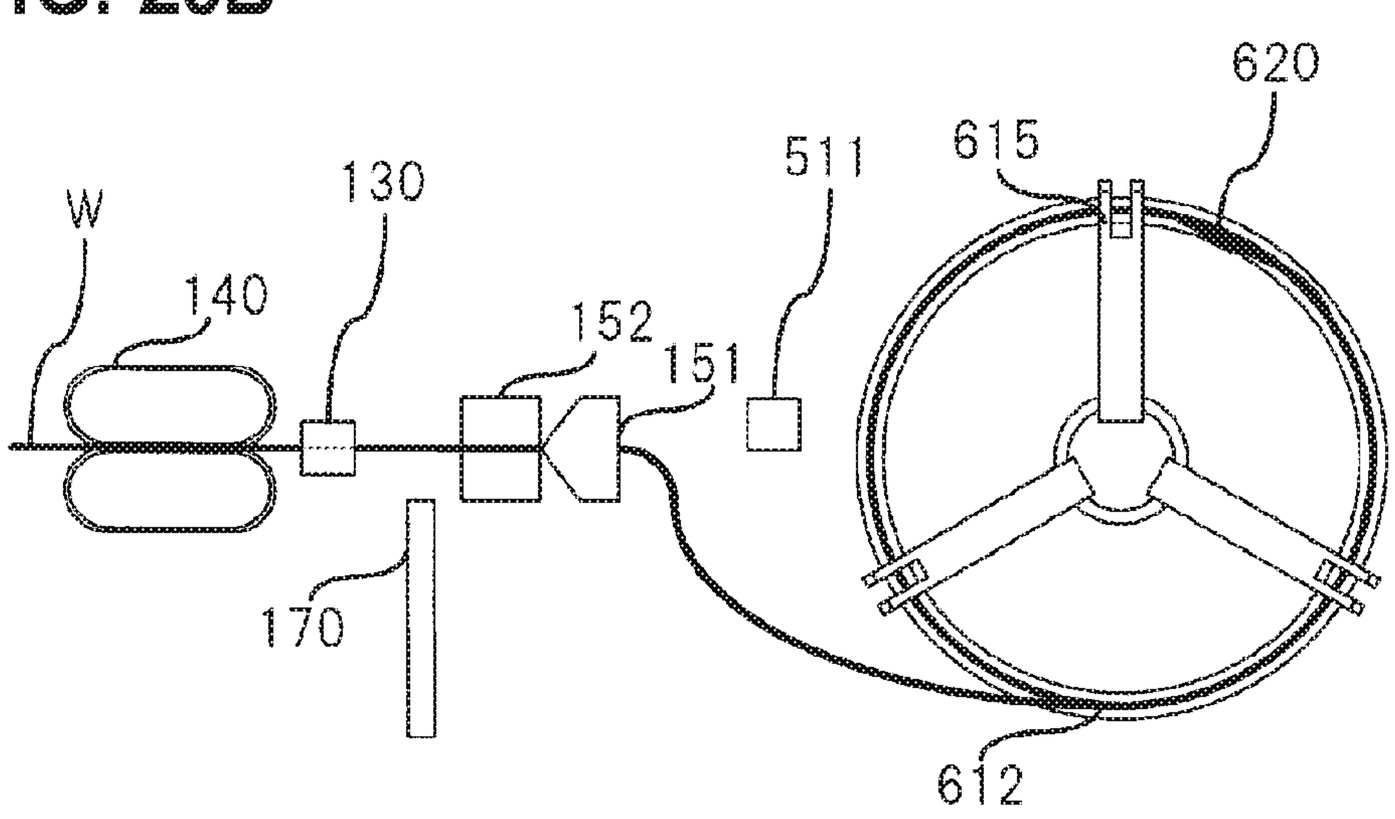
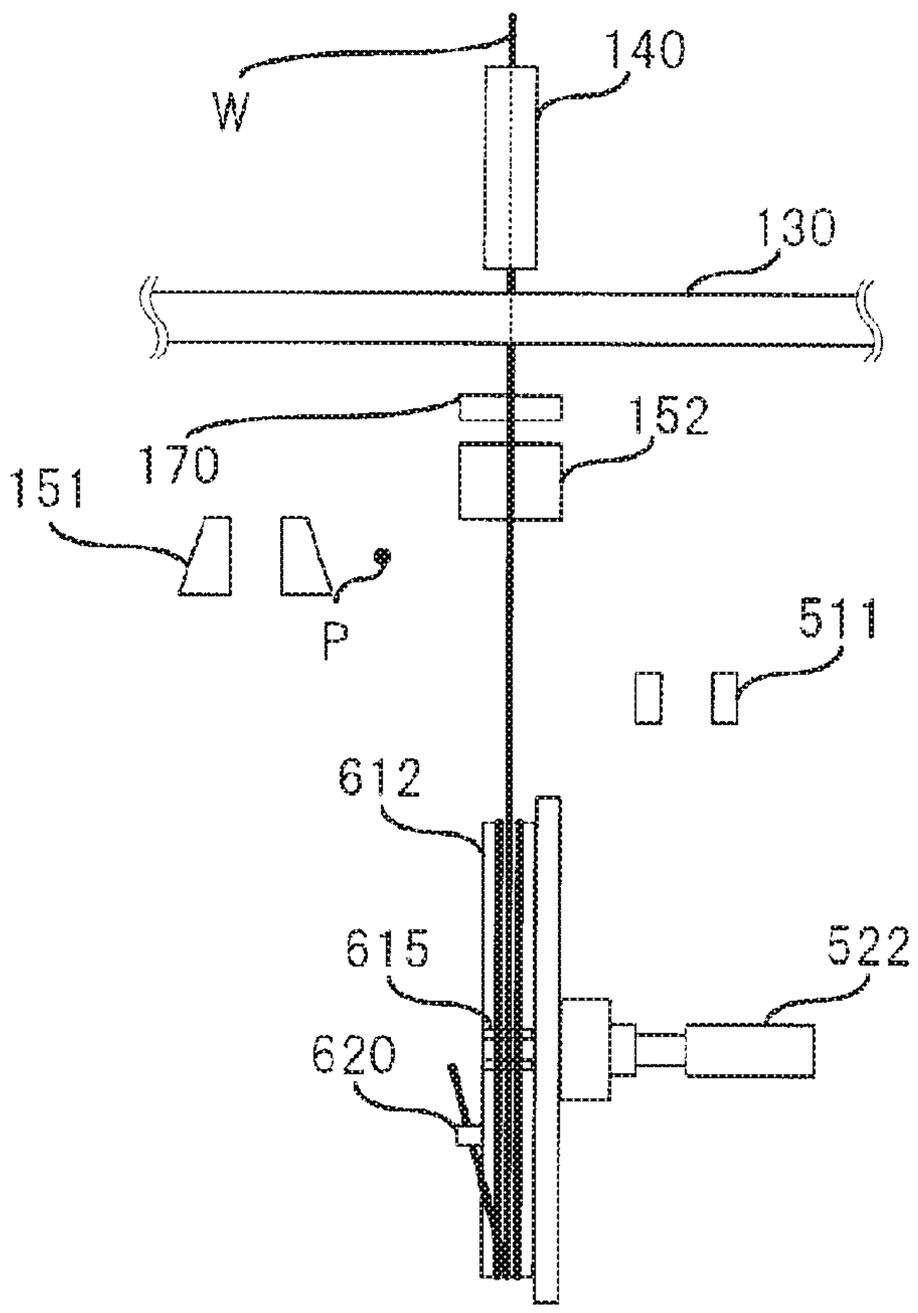


FIG. 27A



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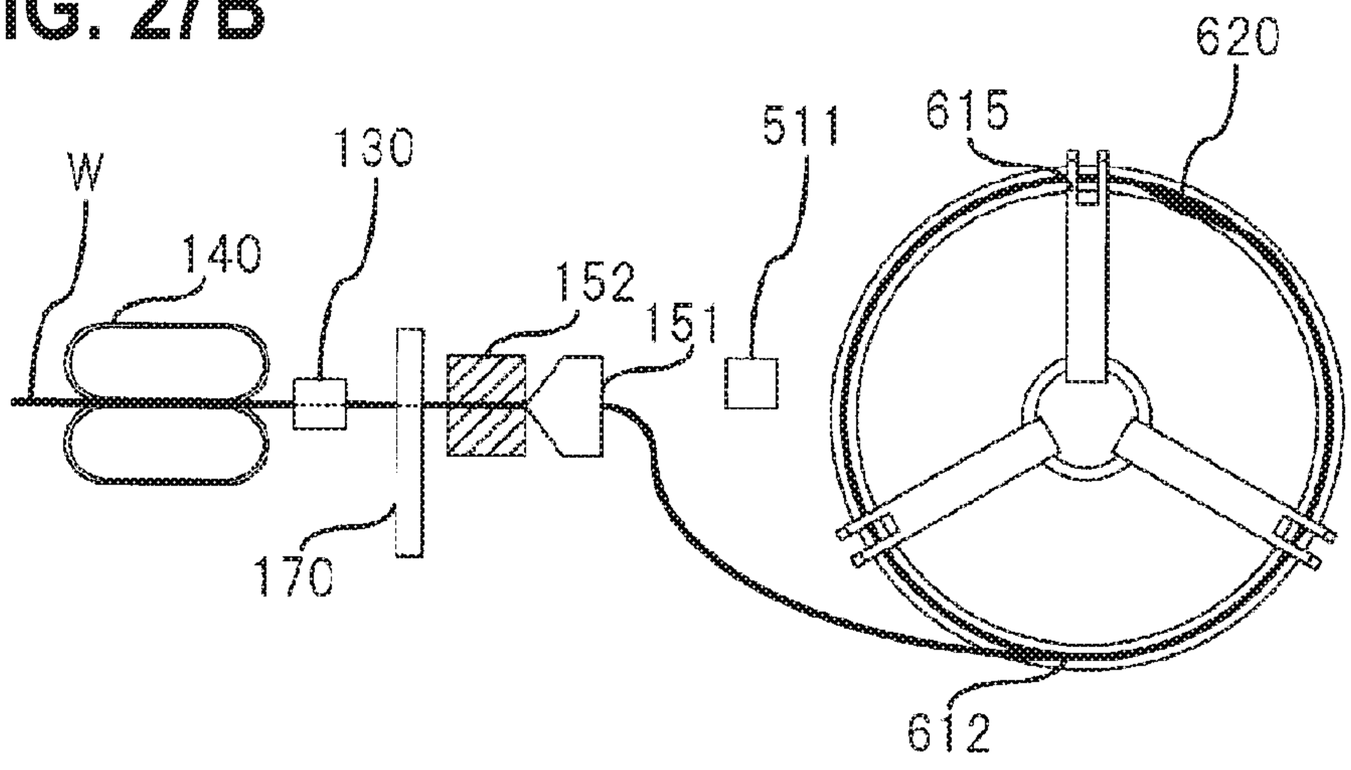


FIG. 28A

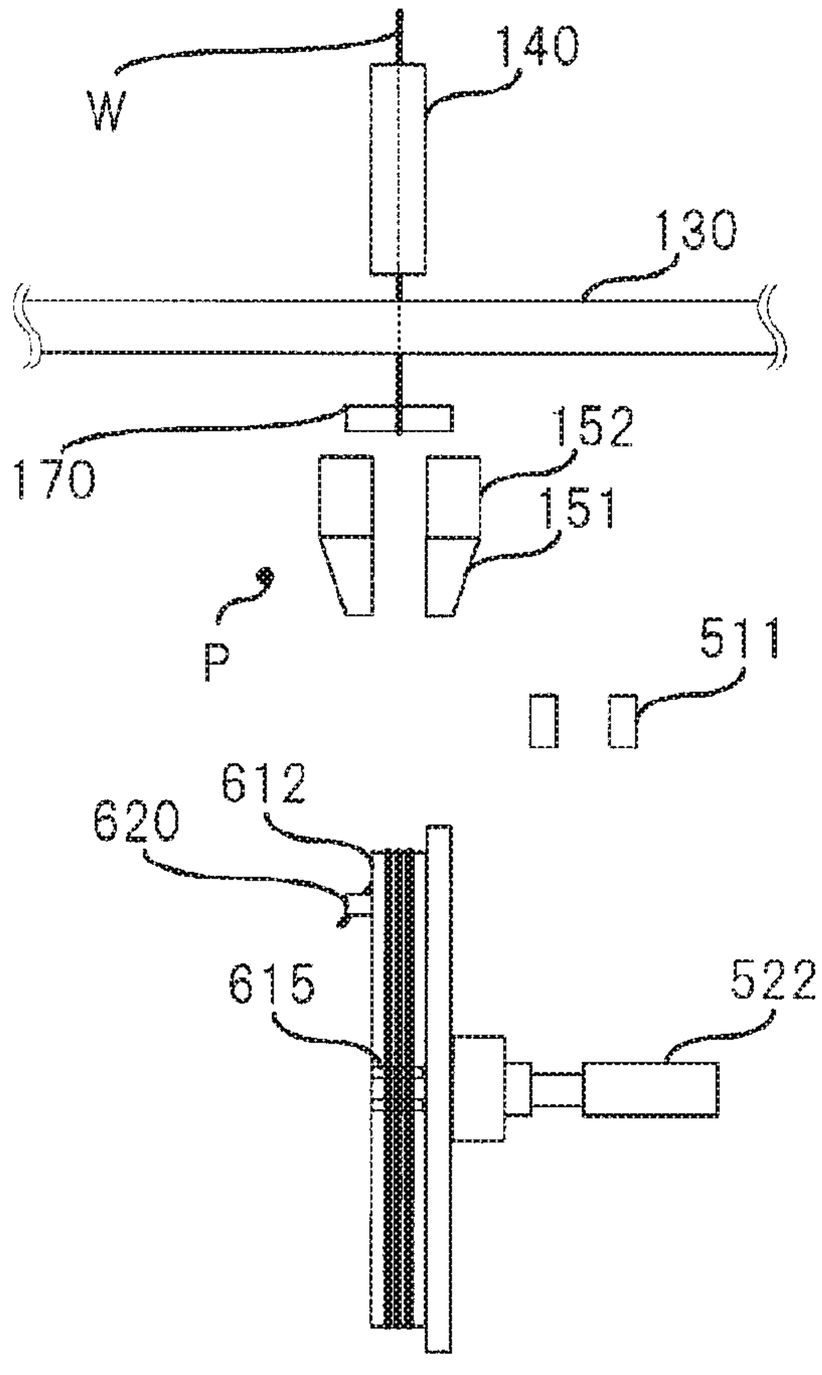


FIG. 28B

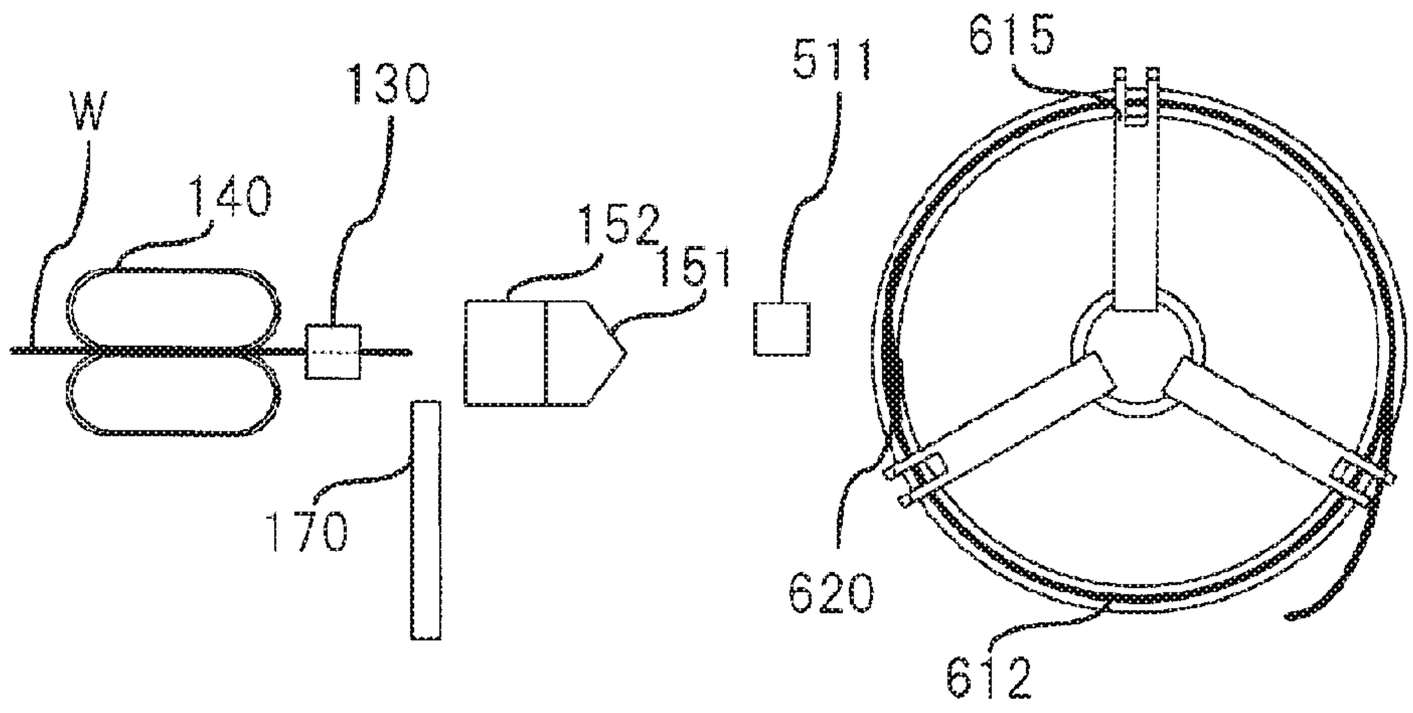


FIG. 29A

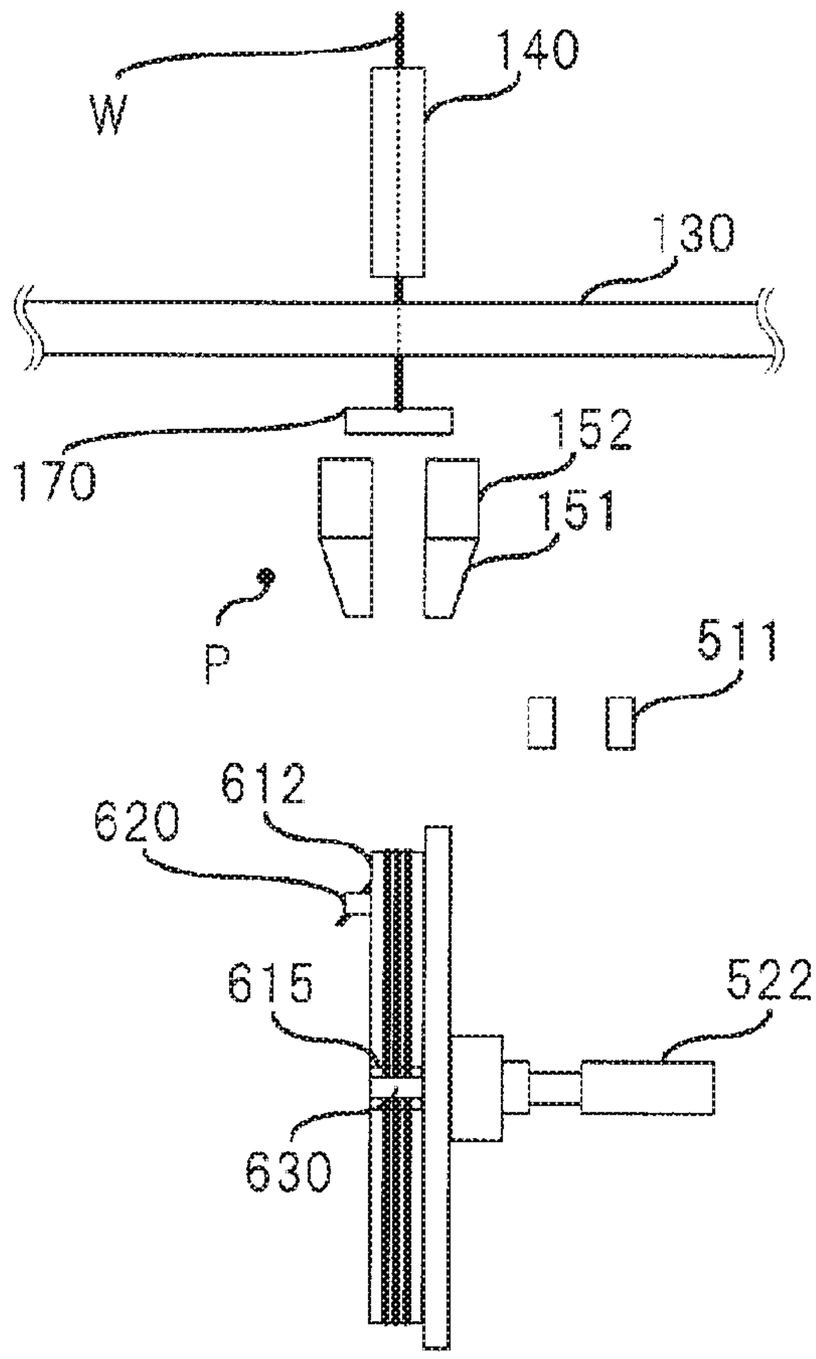


FIG. 29B

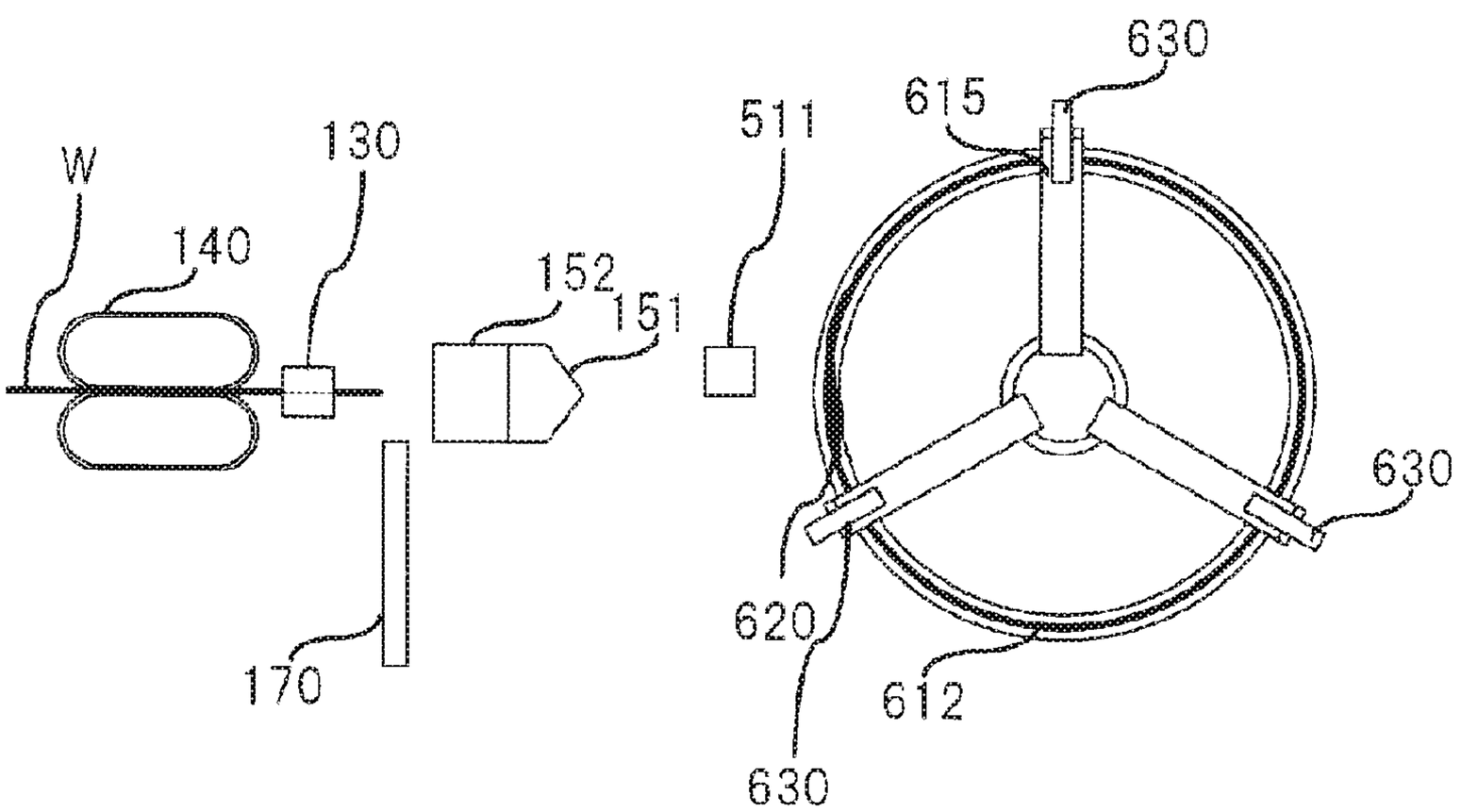


FIG. 30A

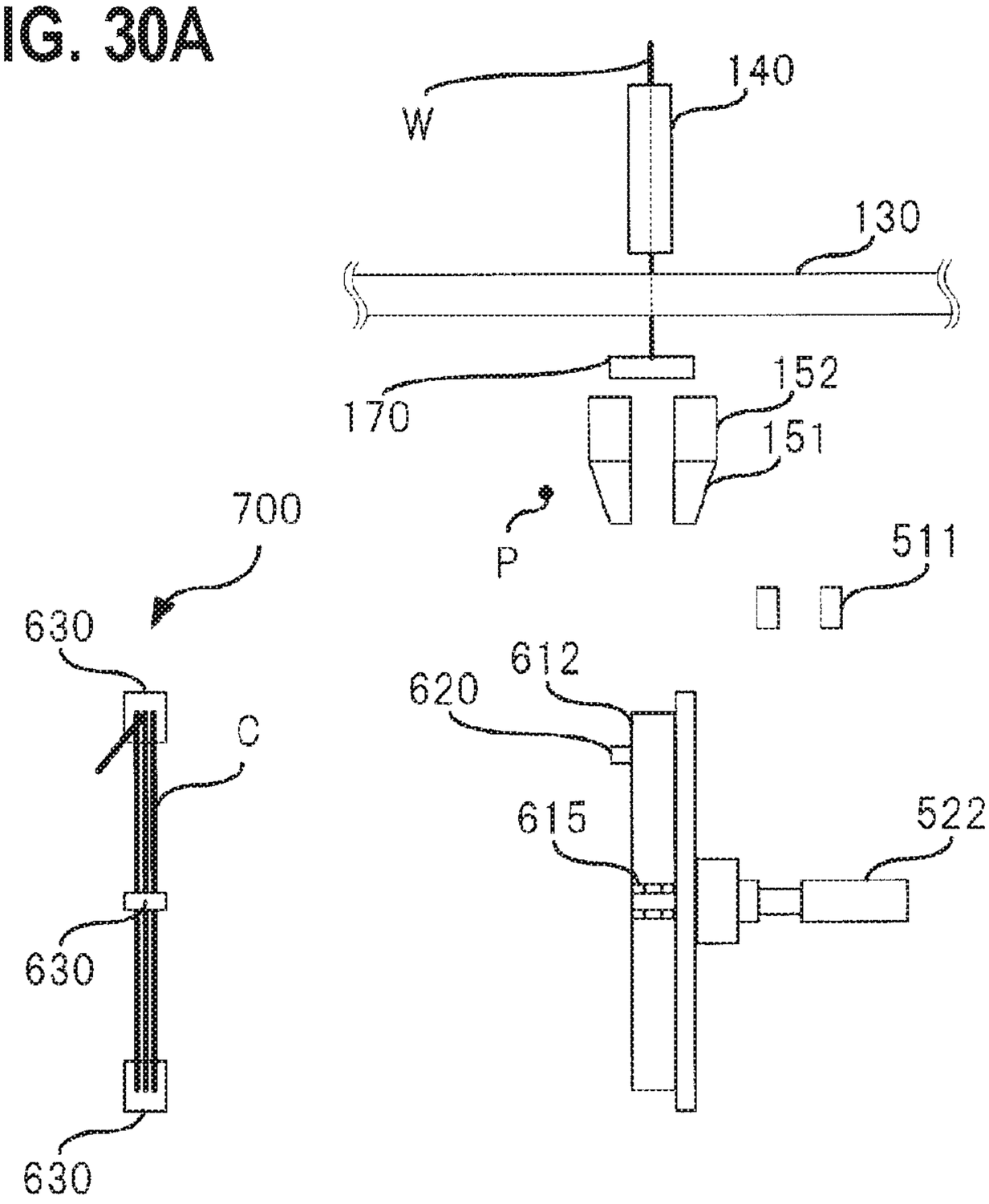


FIG. 30B

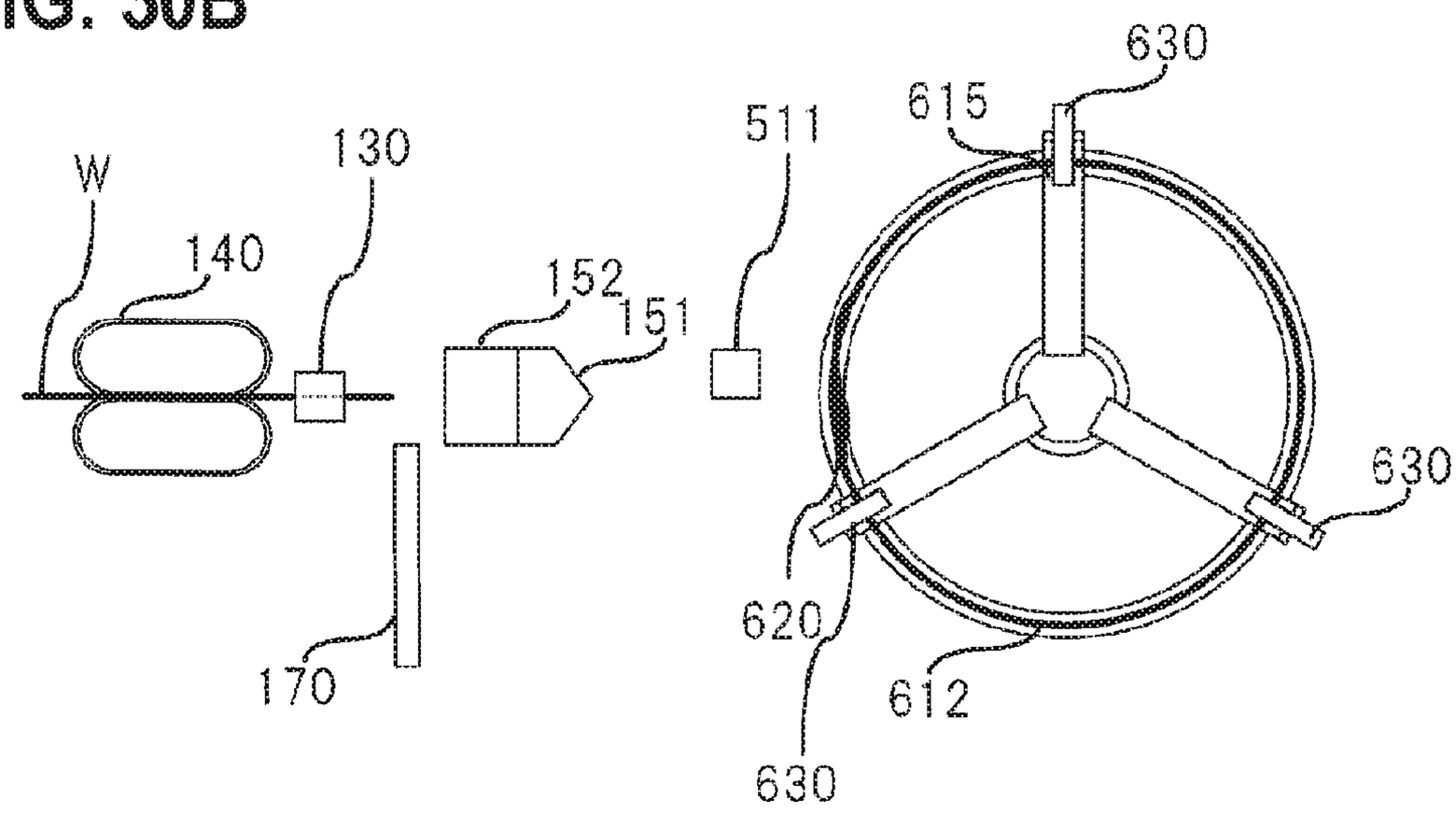


FIG. 31A

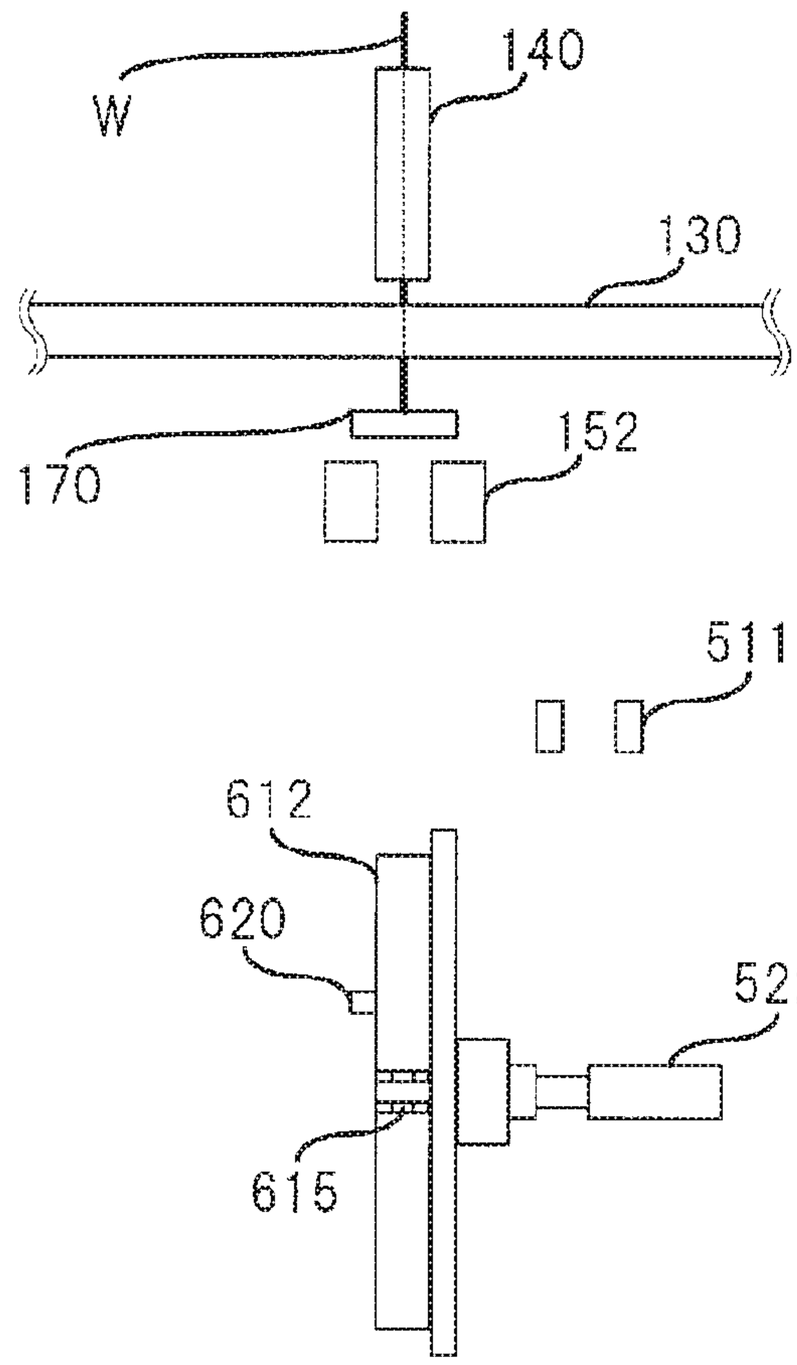


FIG. 31B

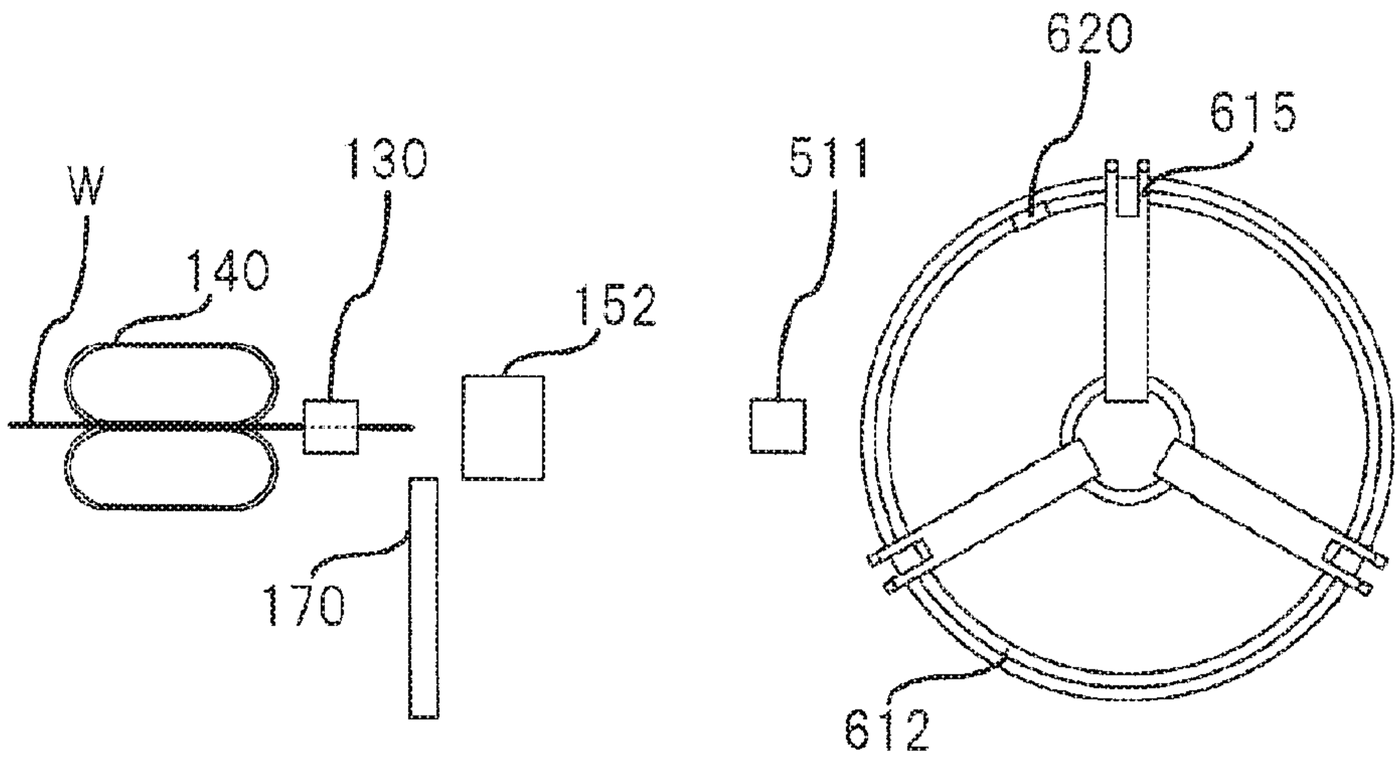


FIG. 32A

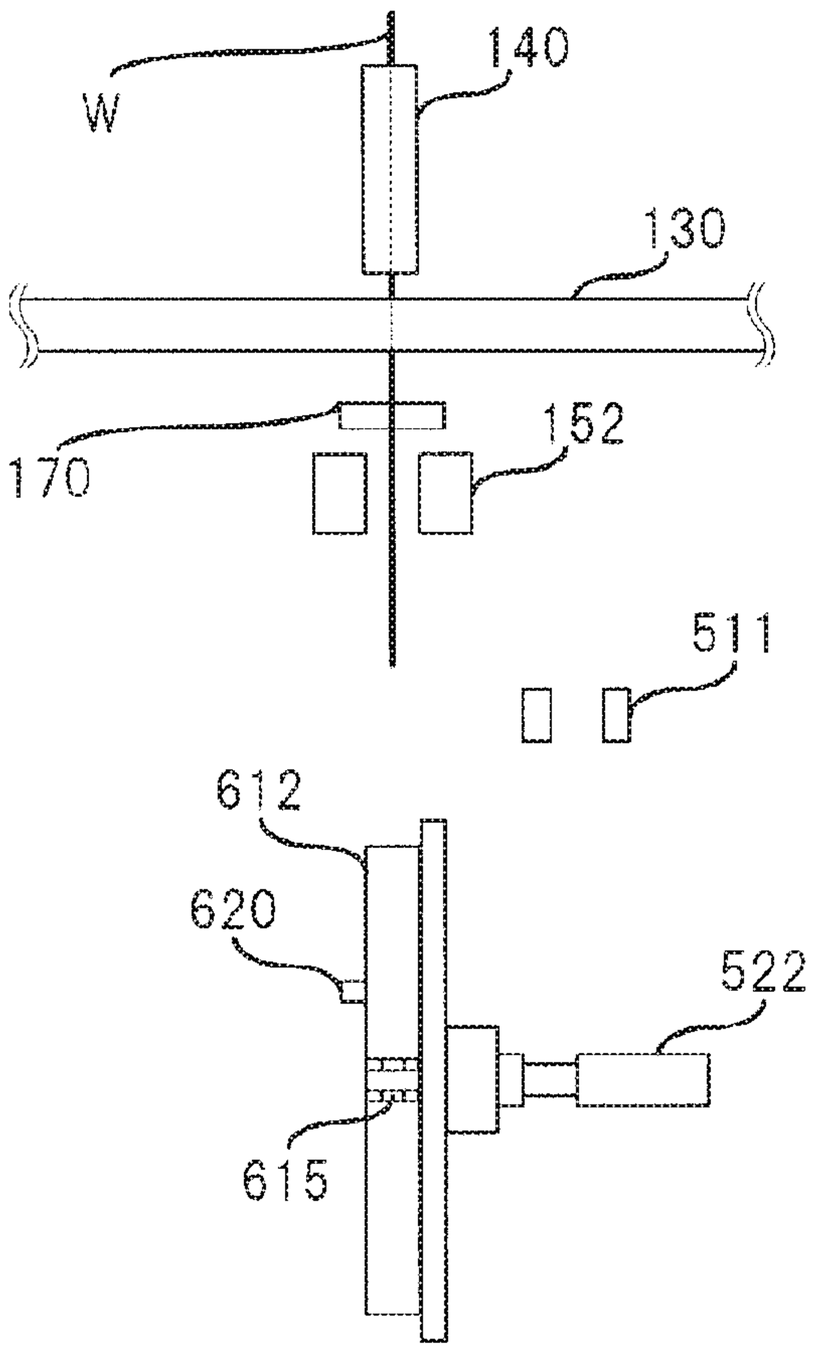


FIG. 32B

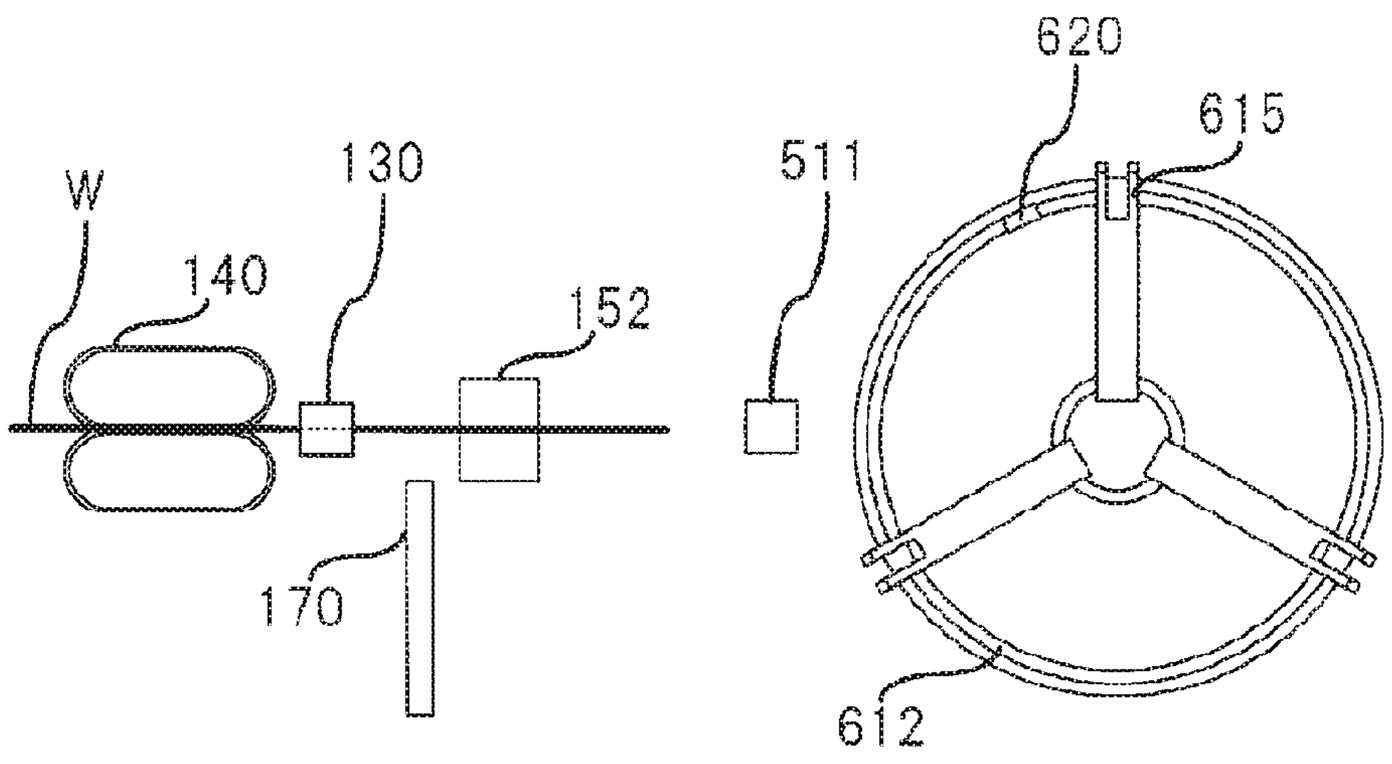


FIG. 33A

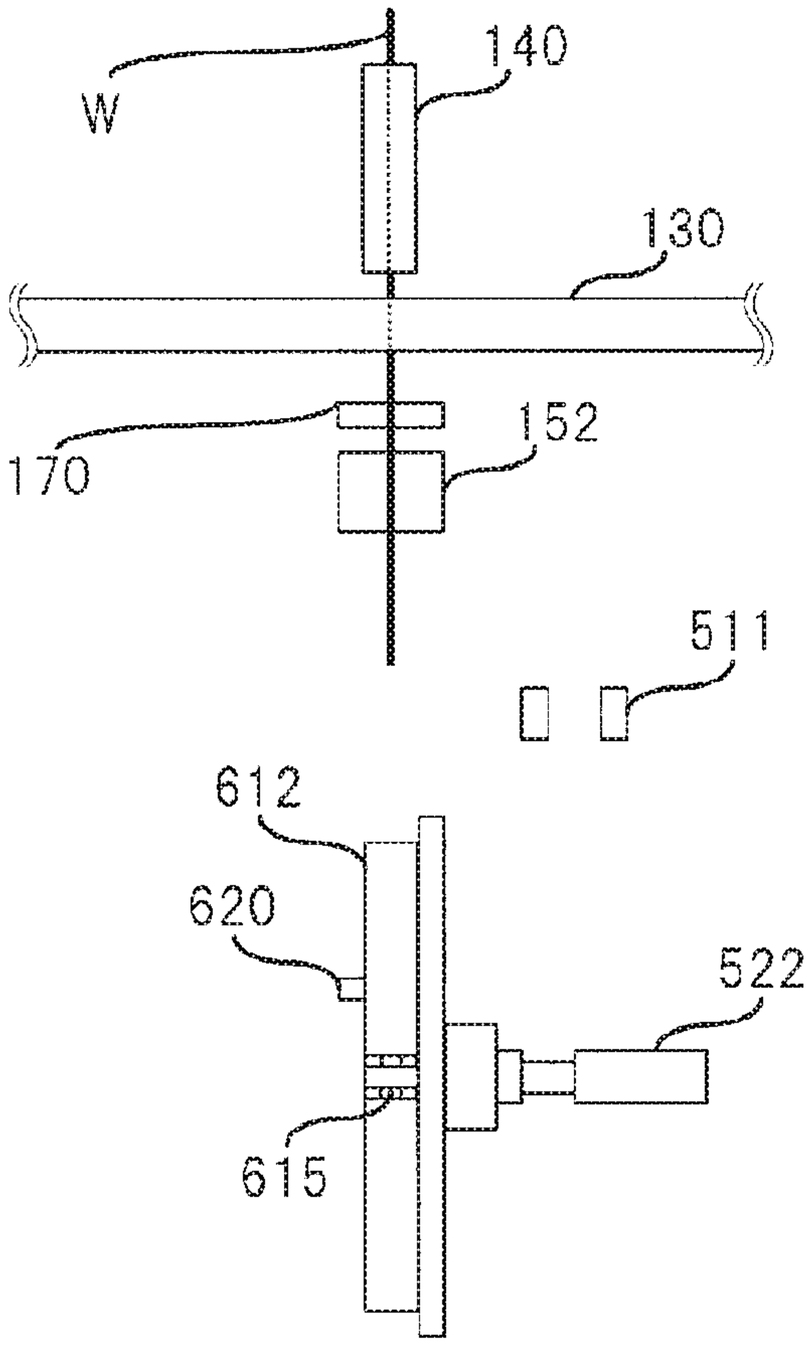
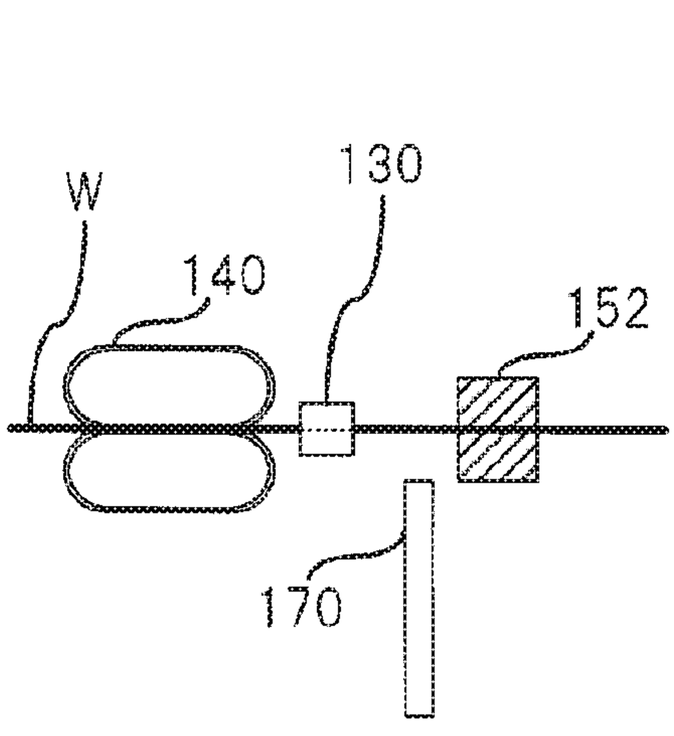


FIG. 33B



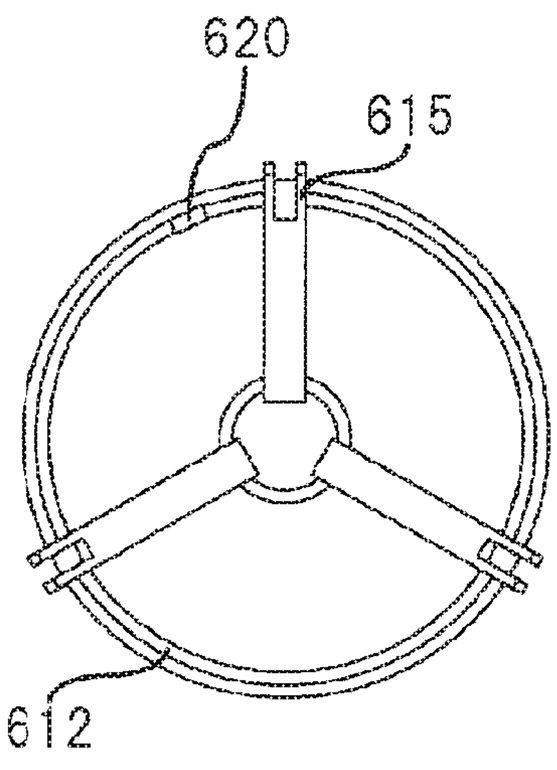


FIG. 34A

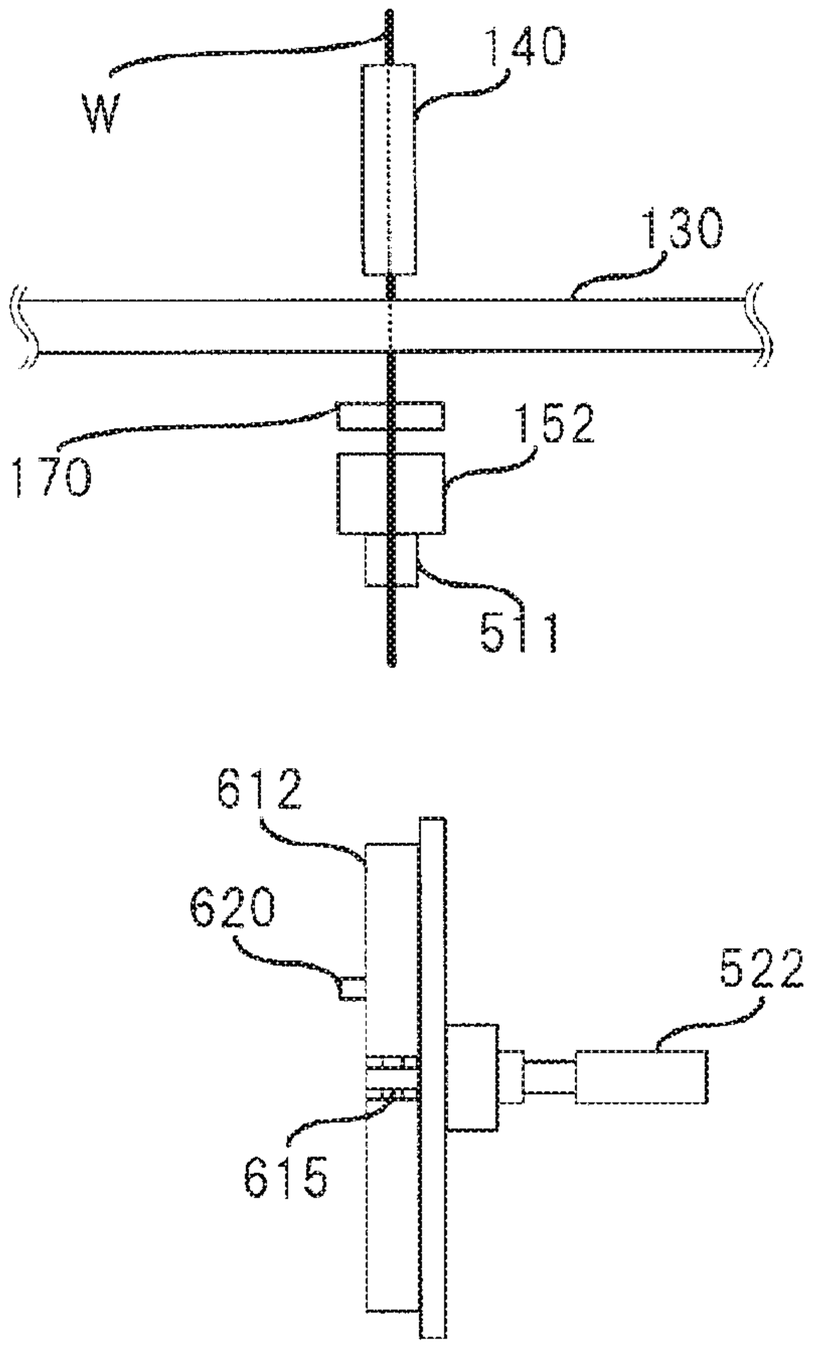
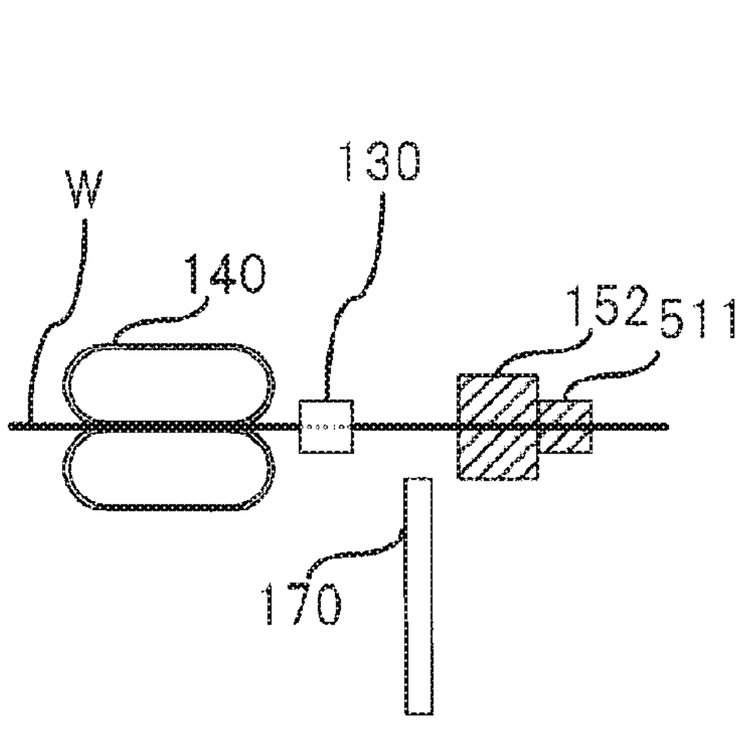


FIG. 34B



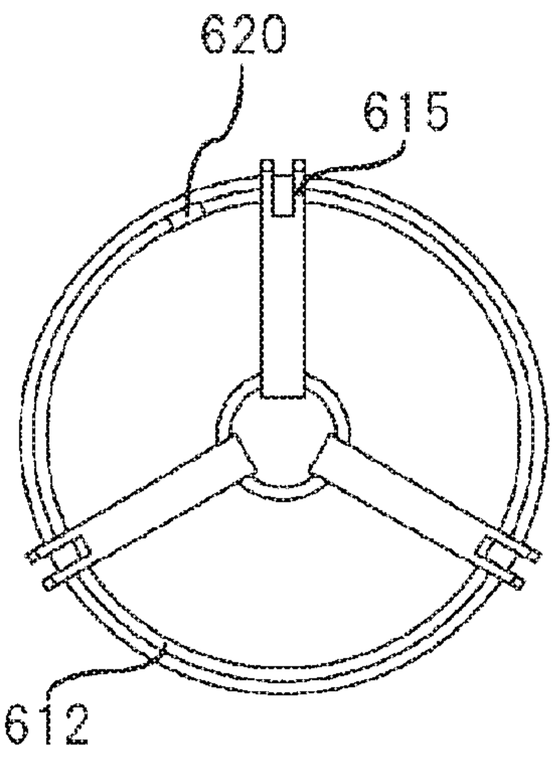


FIG. 35A

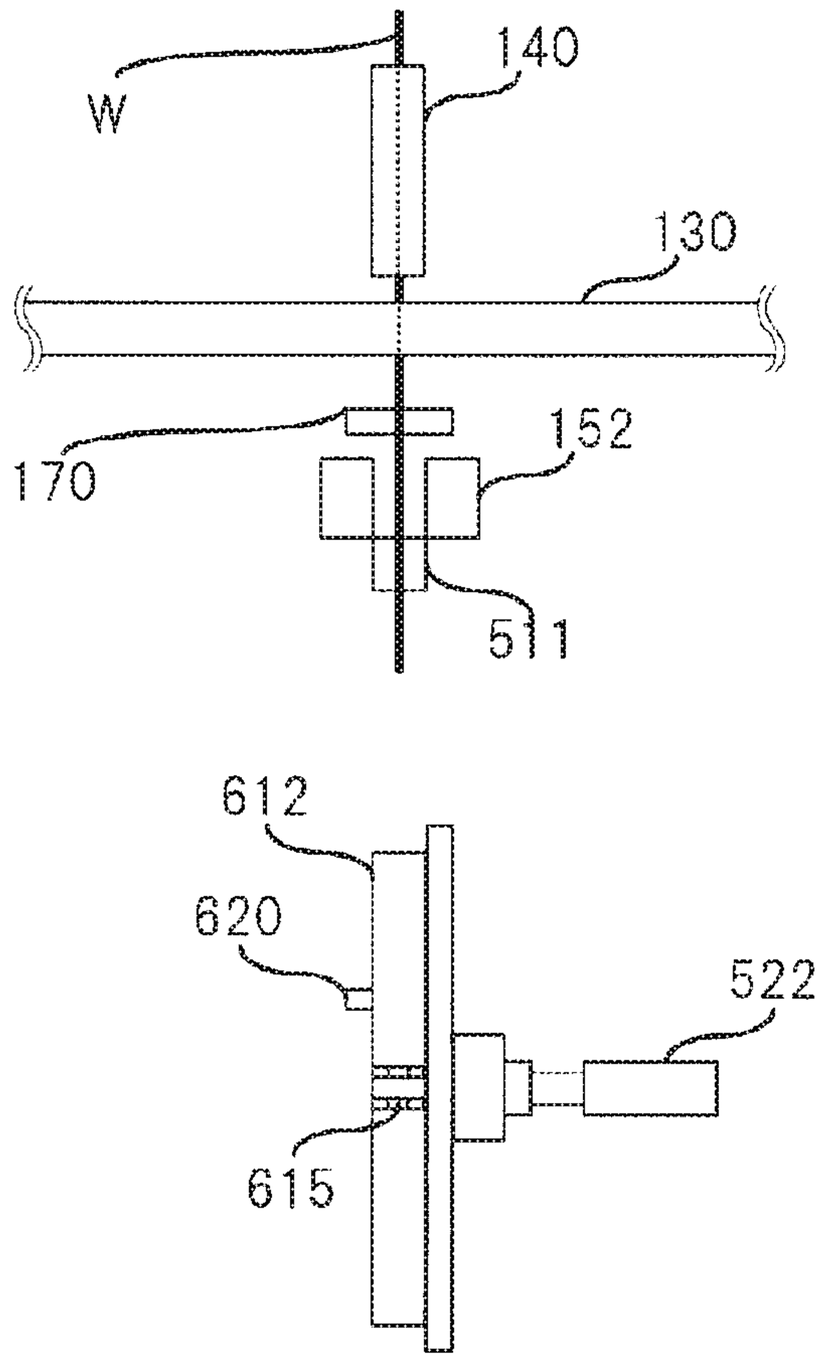


FIG. 35B

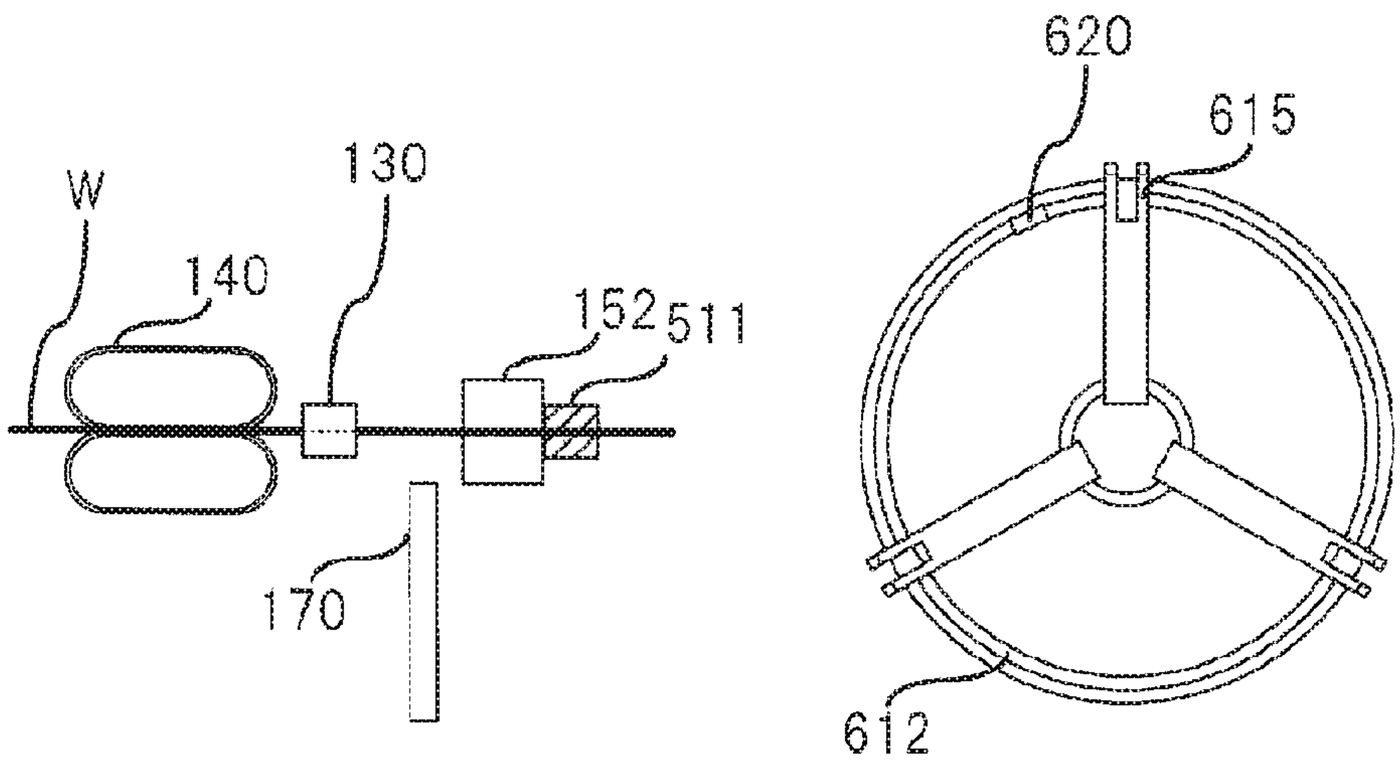


FIG. 36A

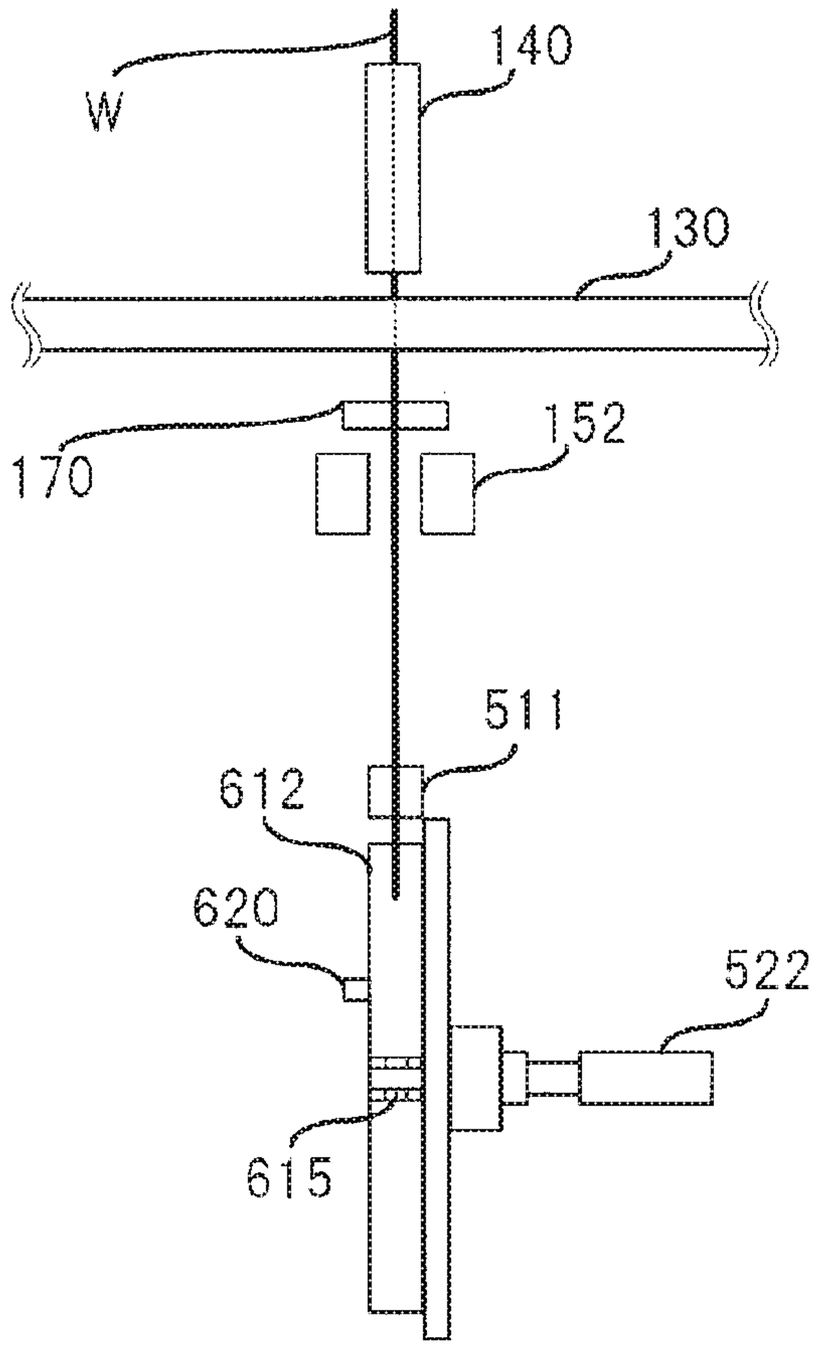


FIG. 36B

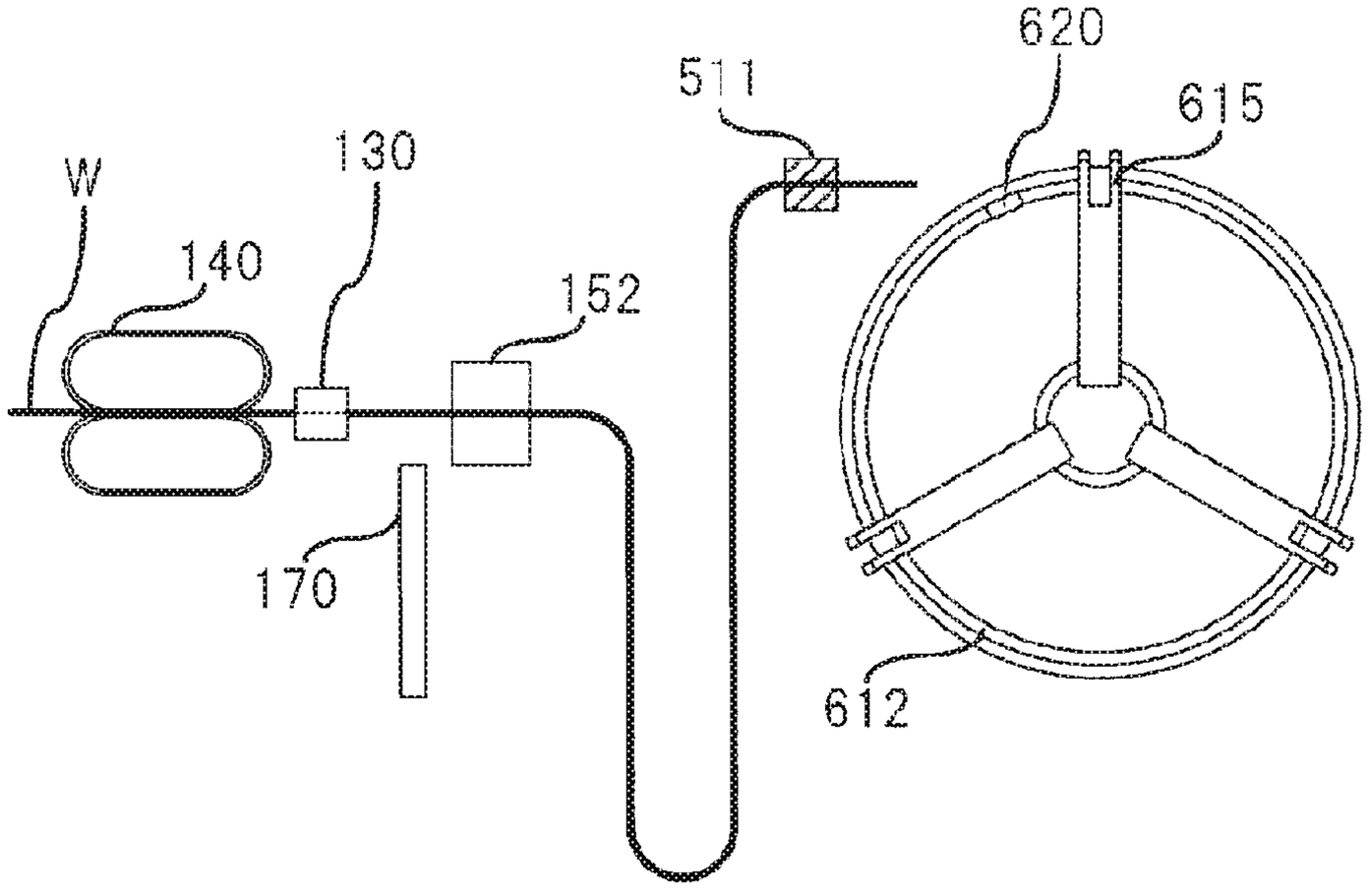


FIG. 37A

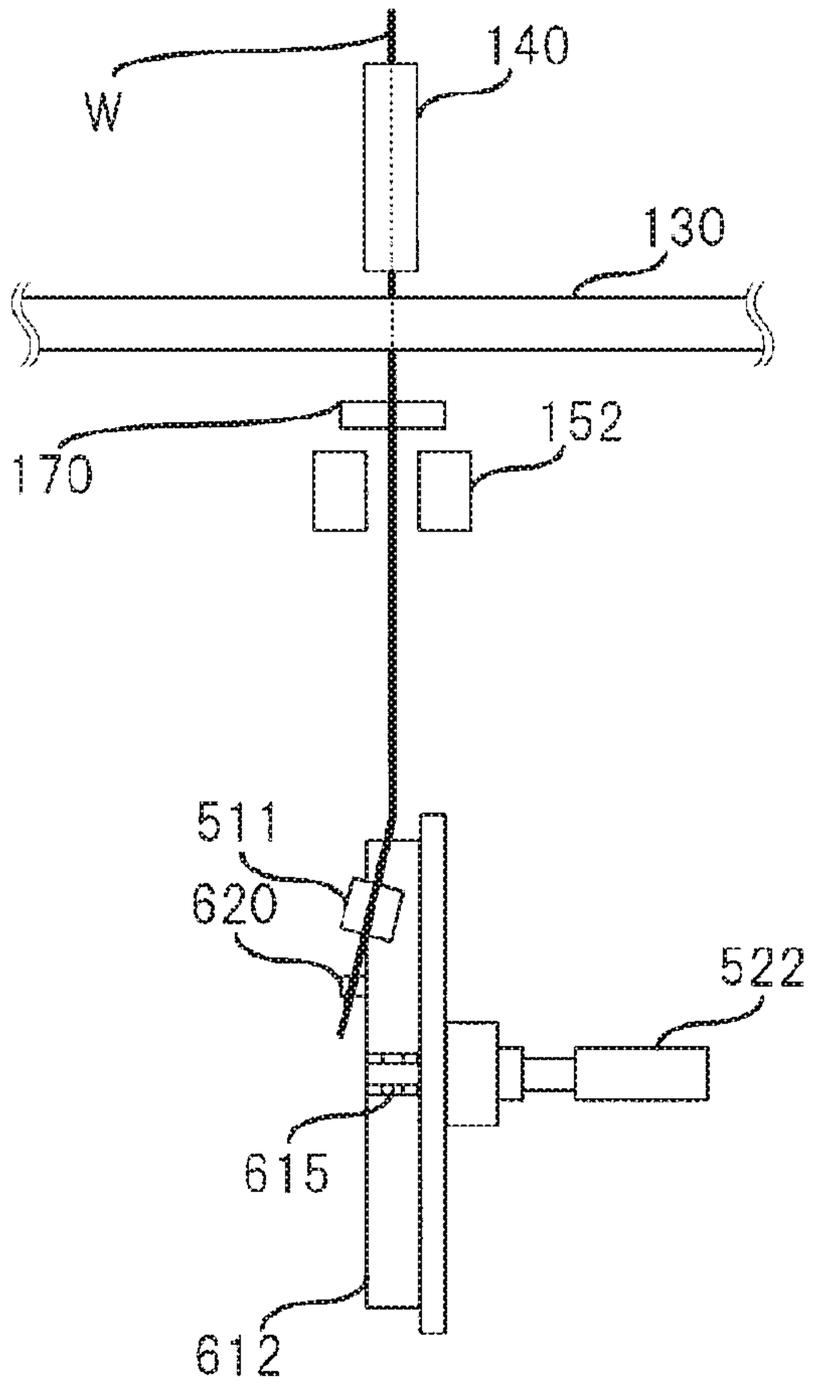


FIG. 37B

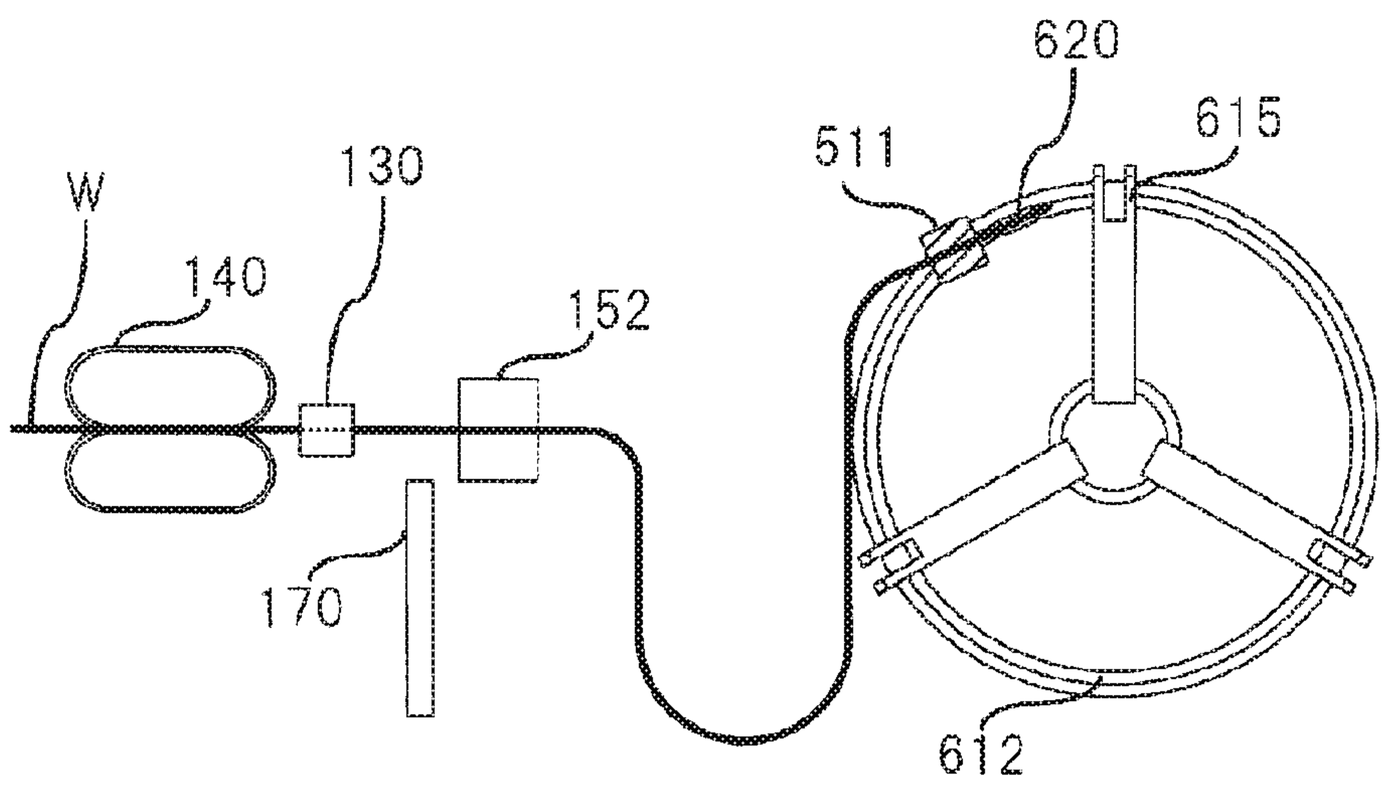


FIG. 38A

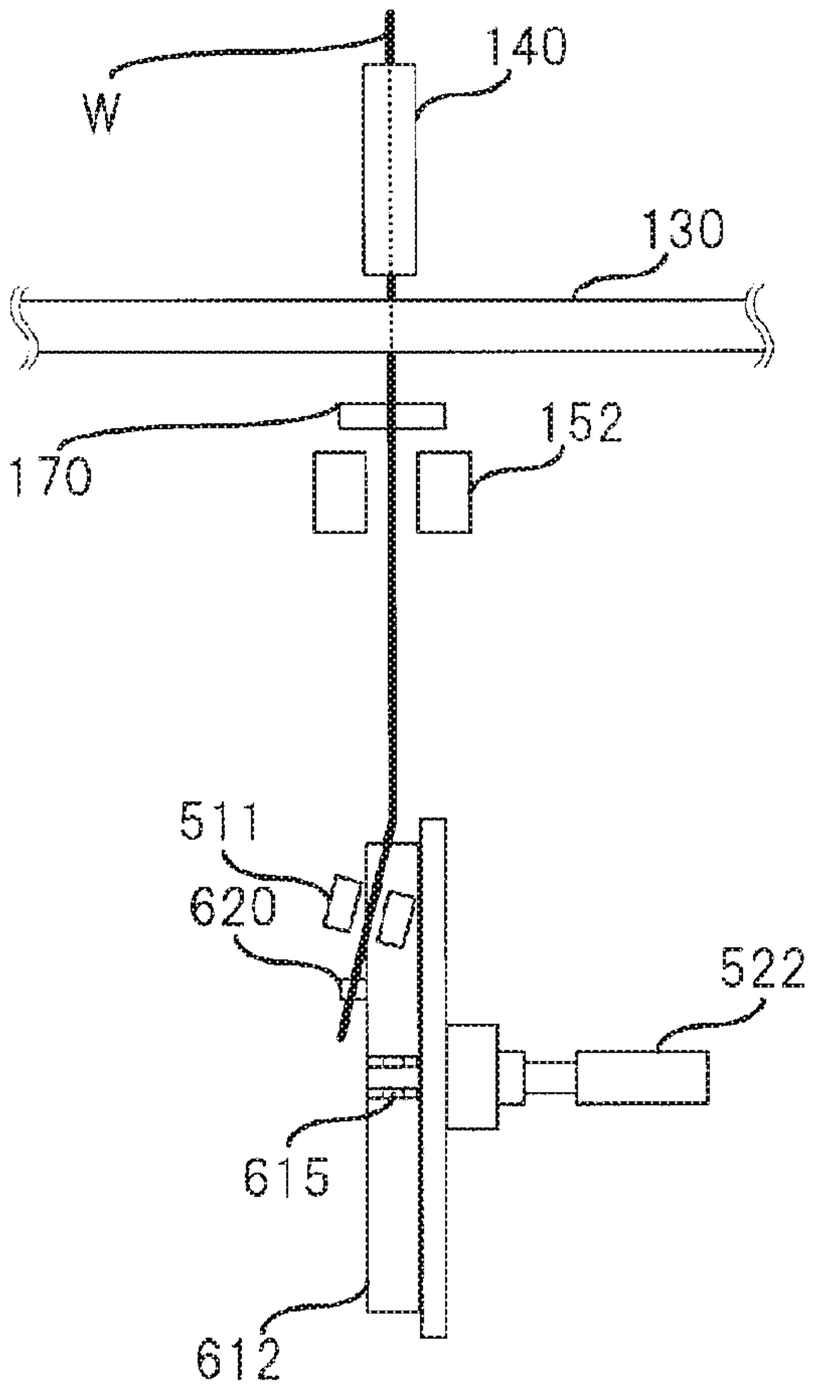


FIG. 38B

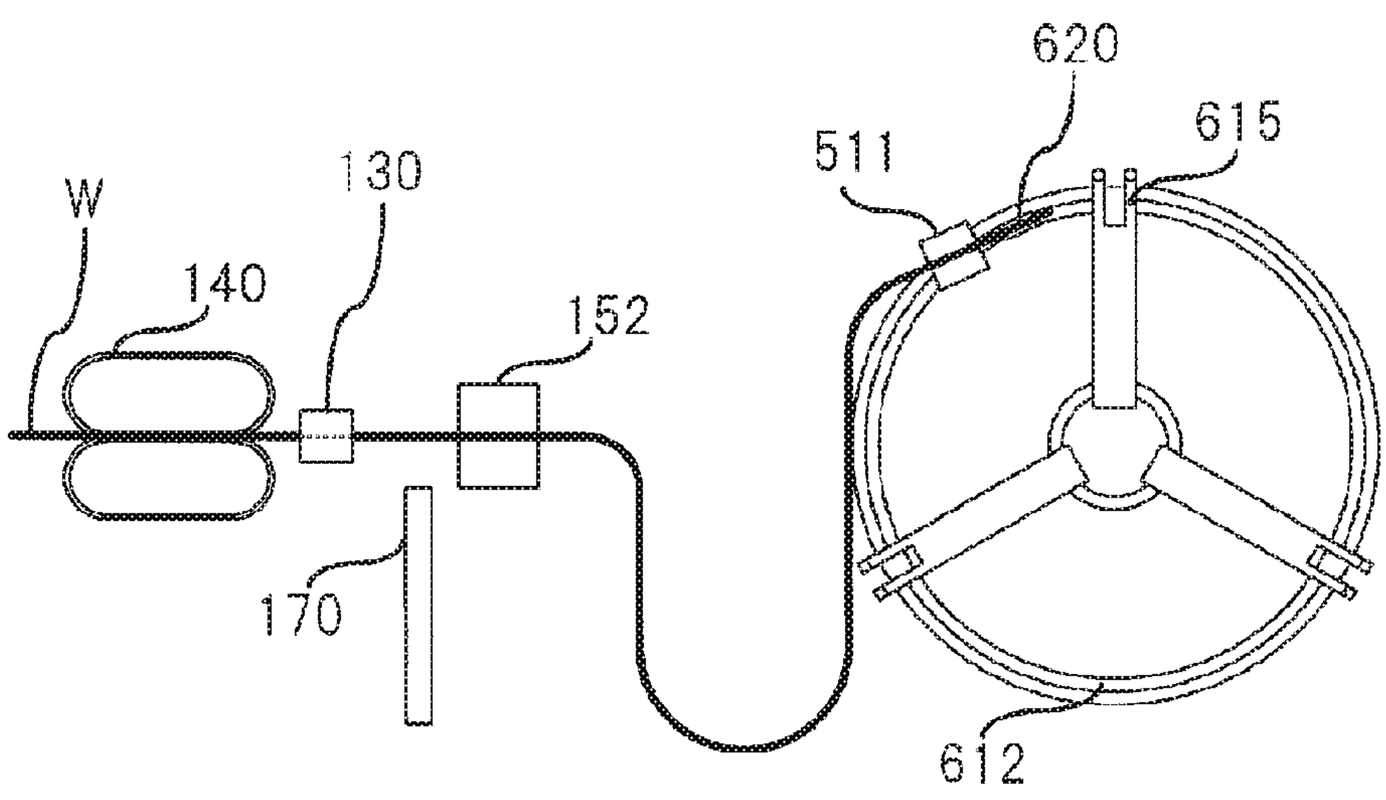


FIG. 39A

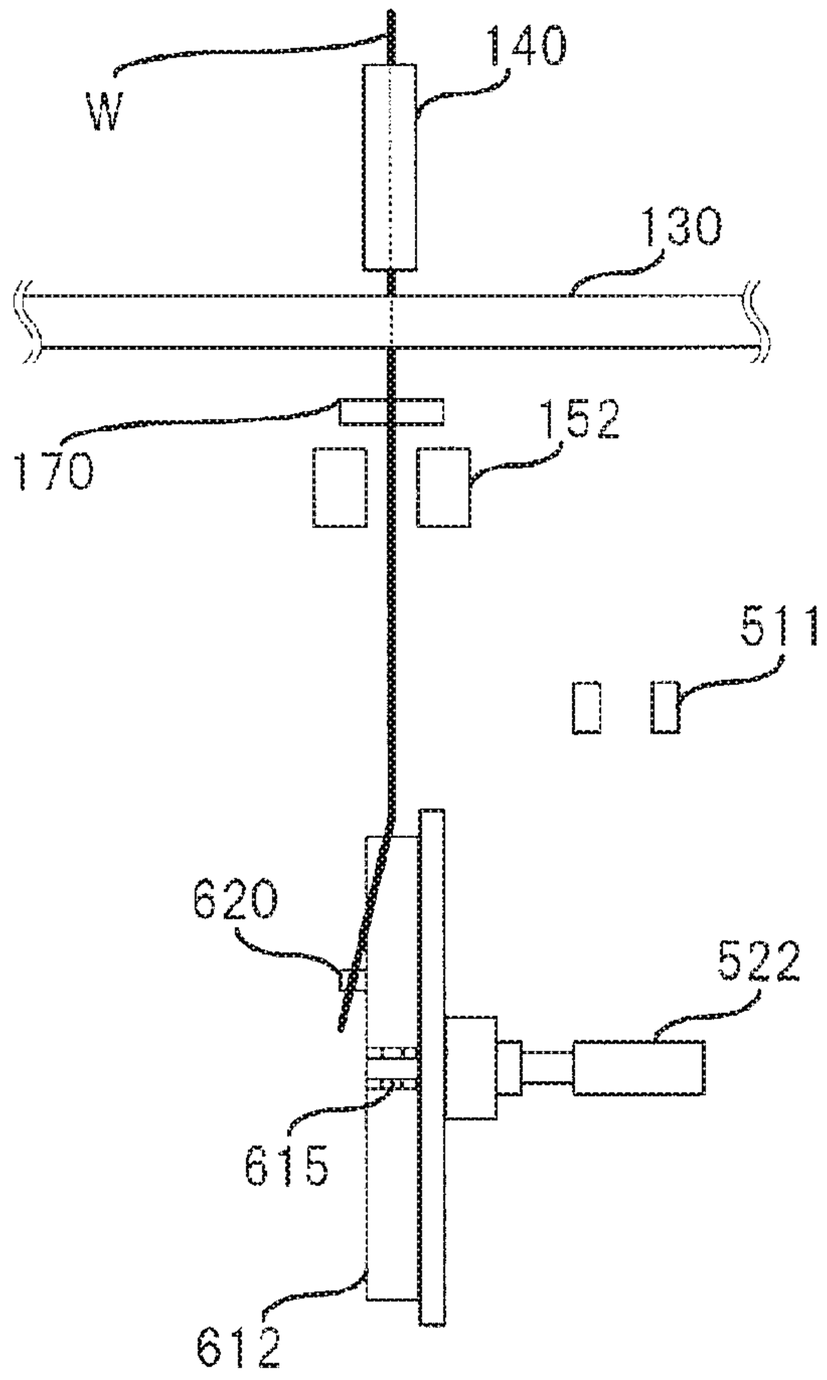


FIG. 39B

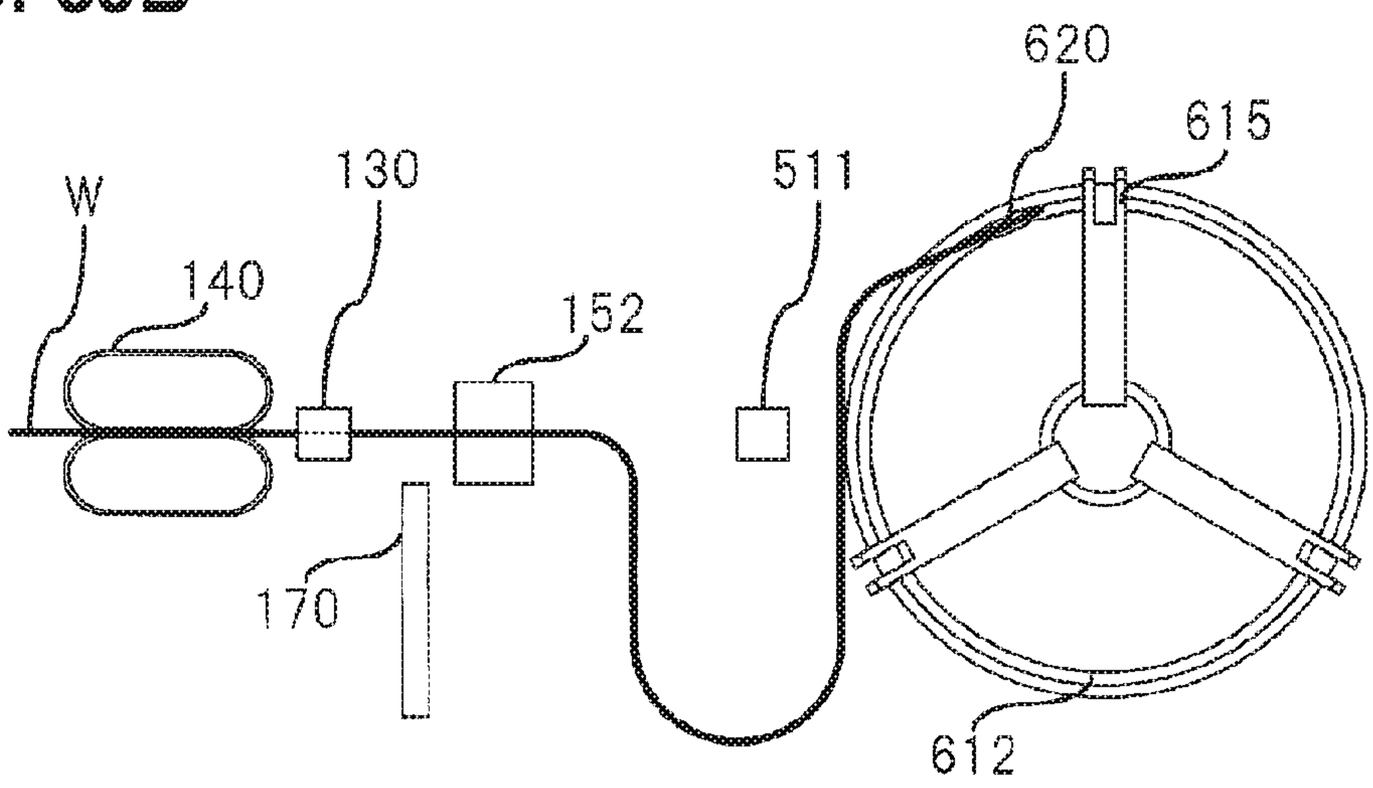


FIG. 40A

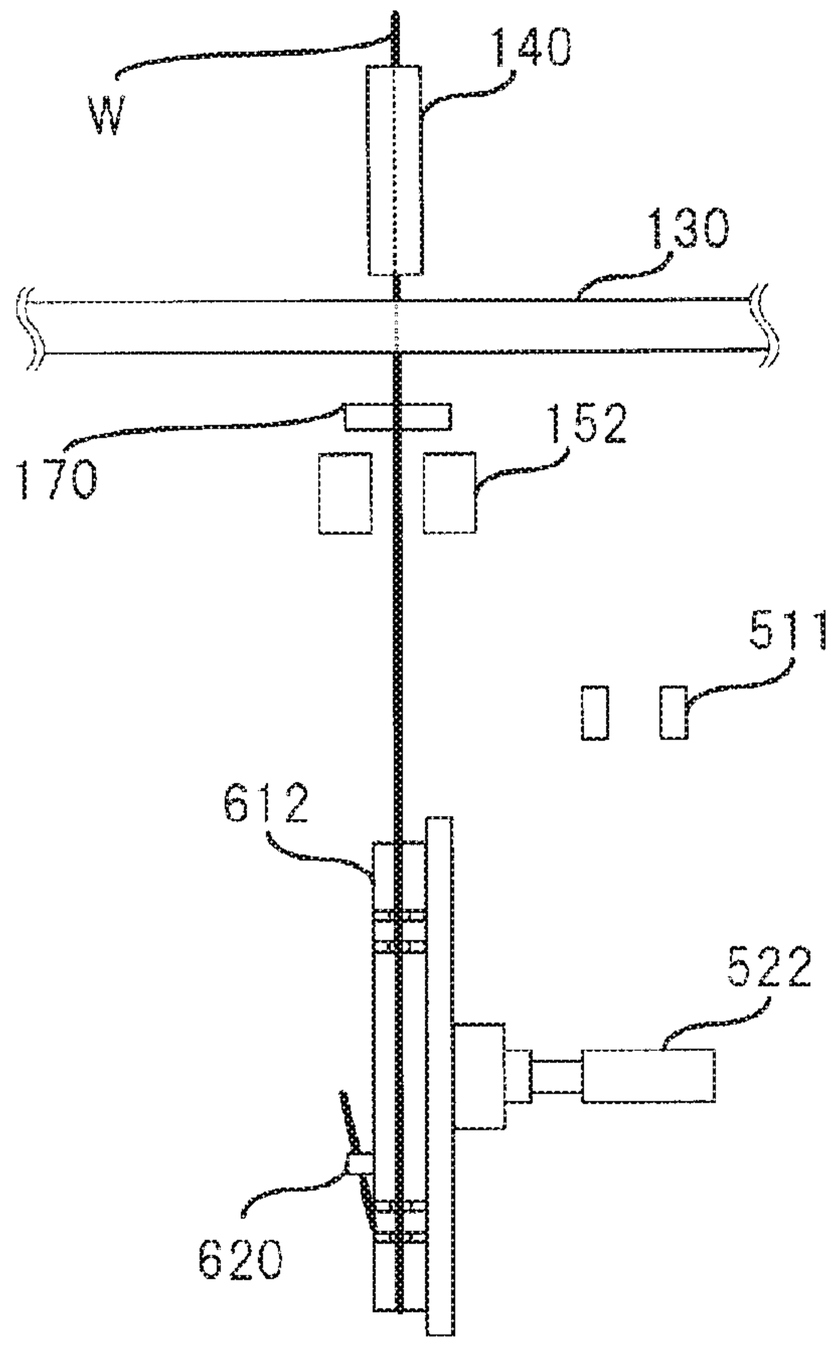


FIG. 40B

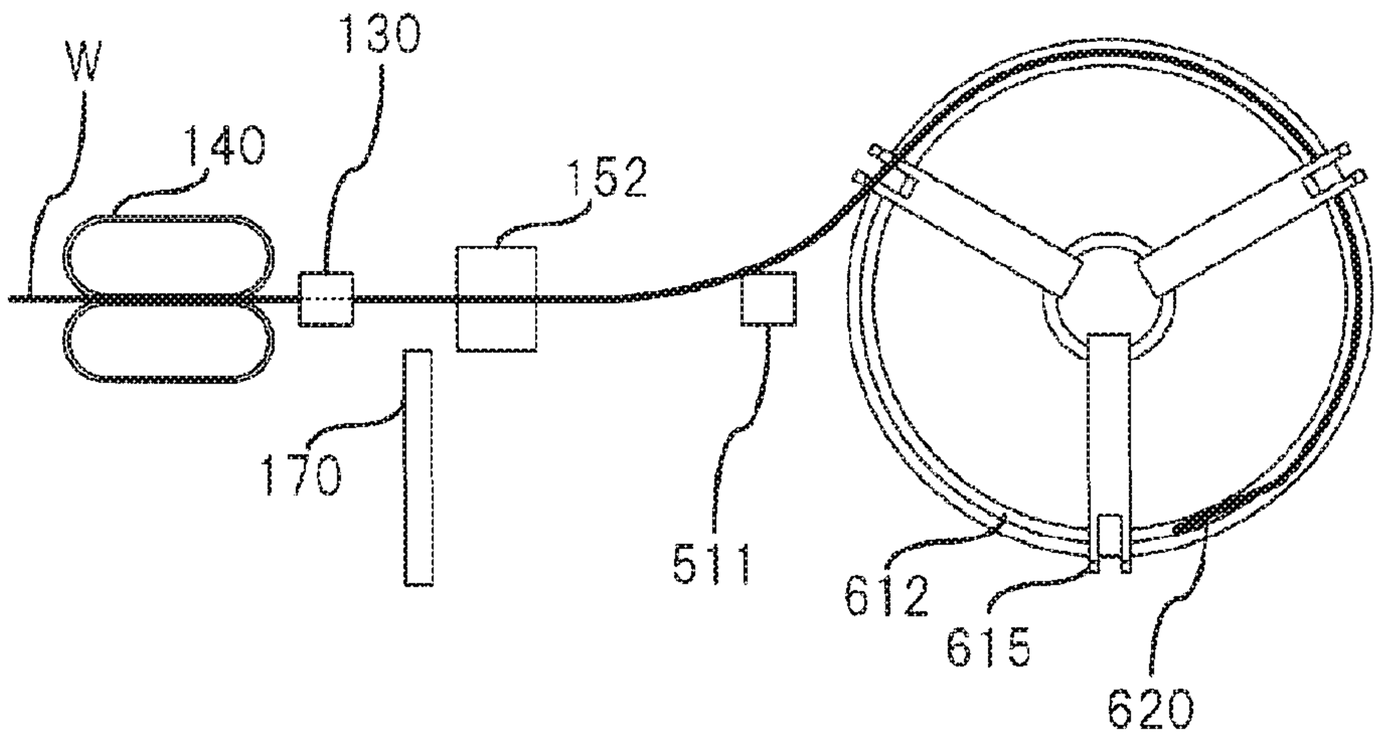


FIG. 41A

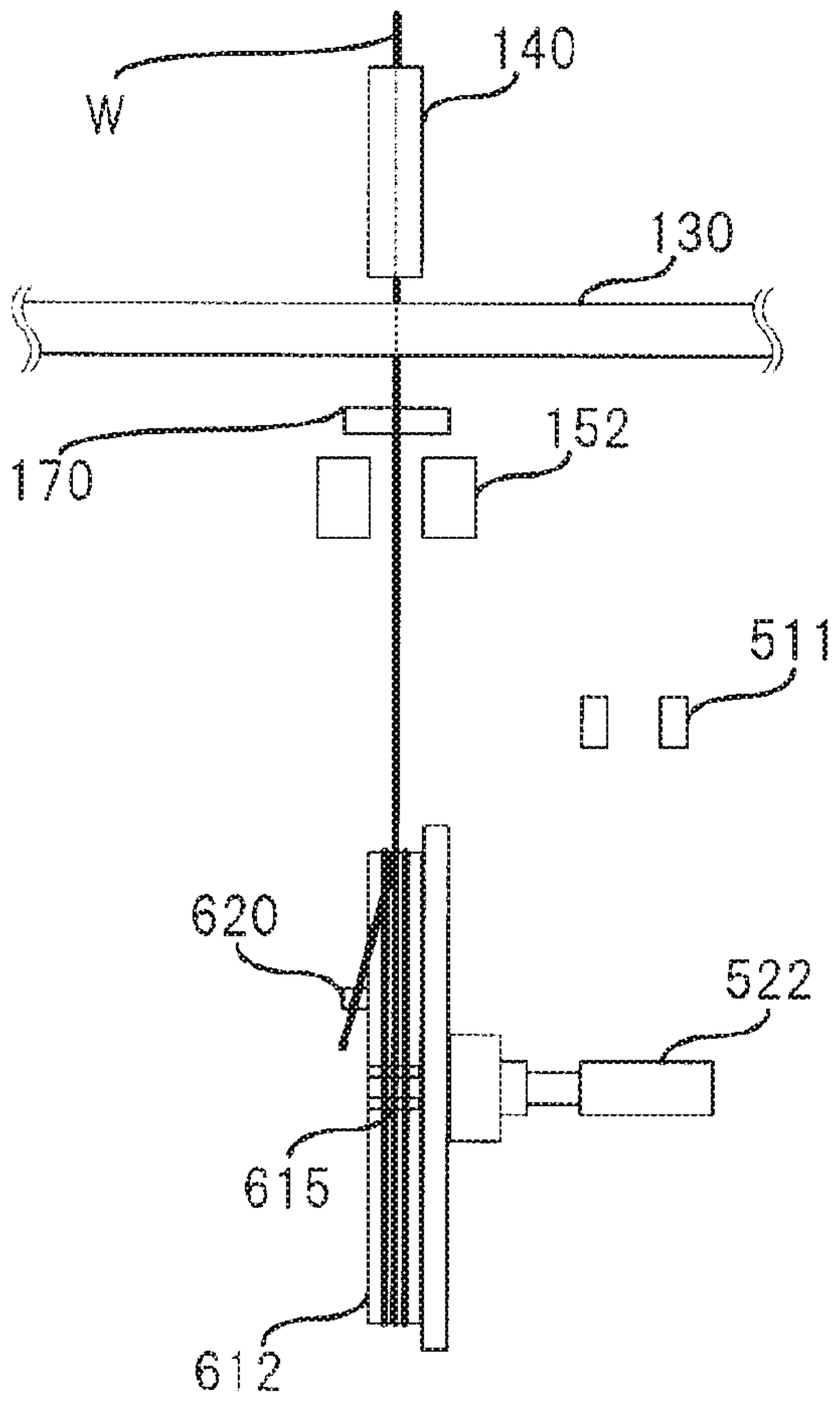


FIG. 41B

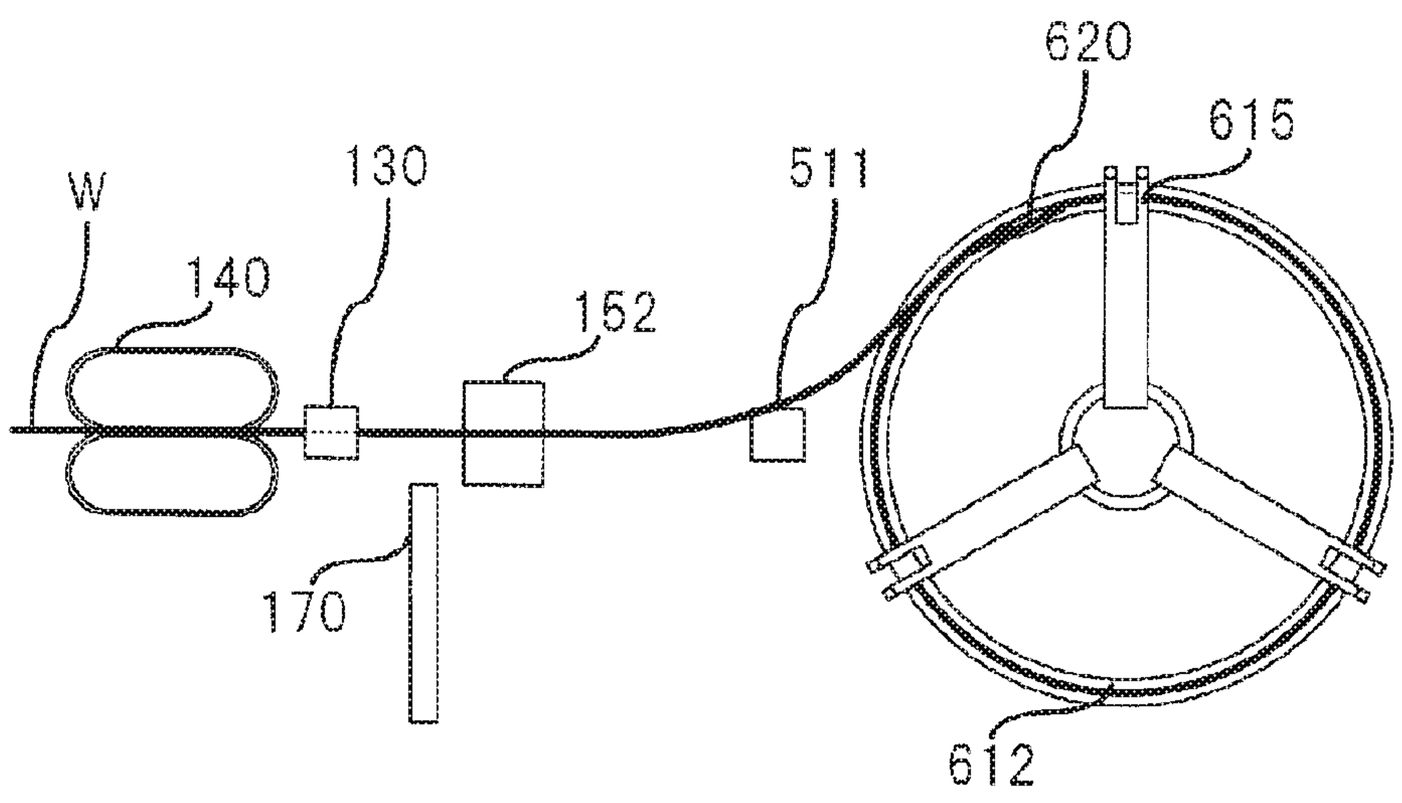


FIG. 42A

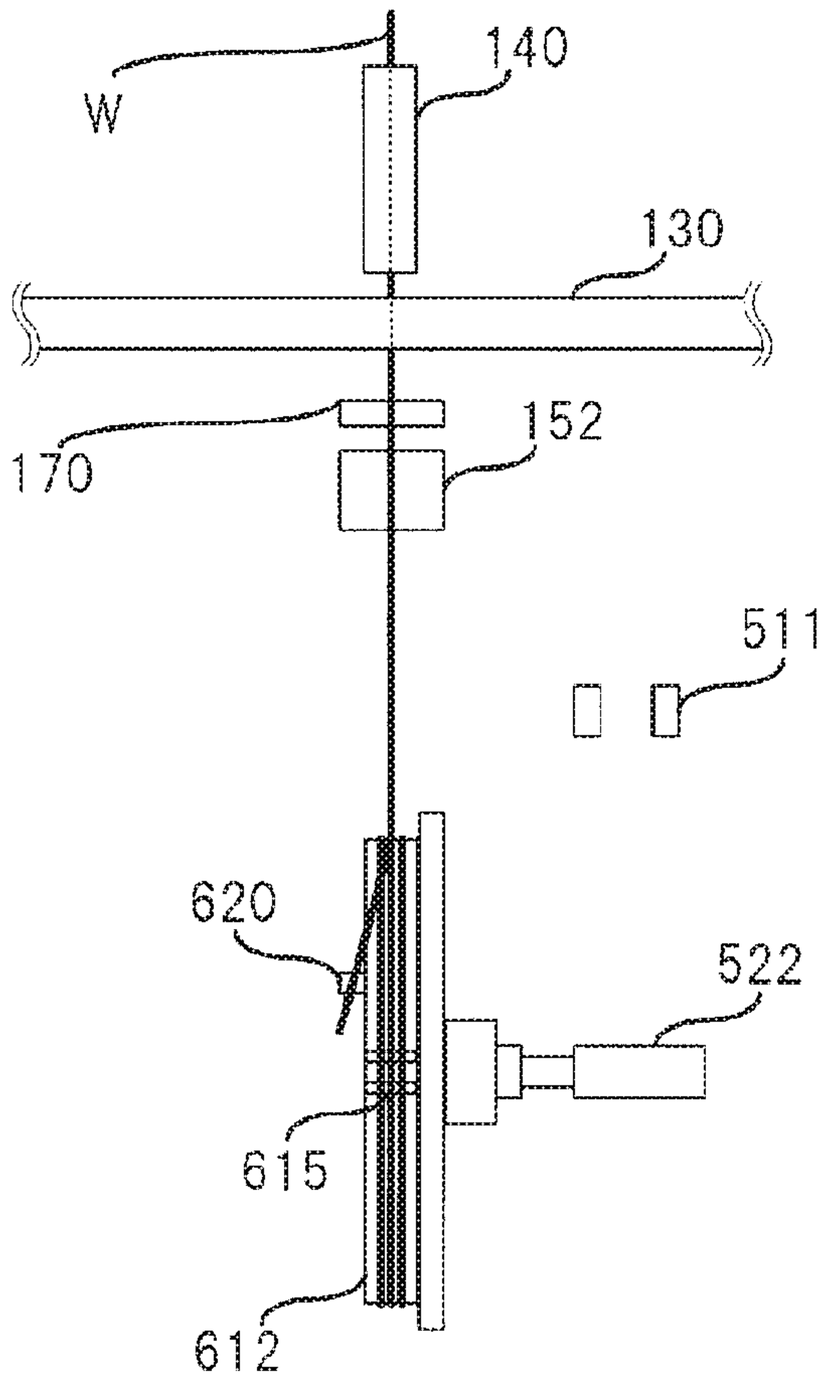


FIG. 42B

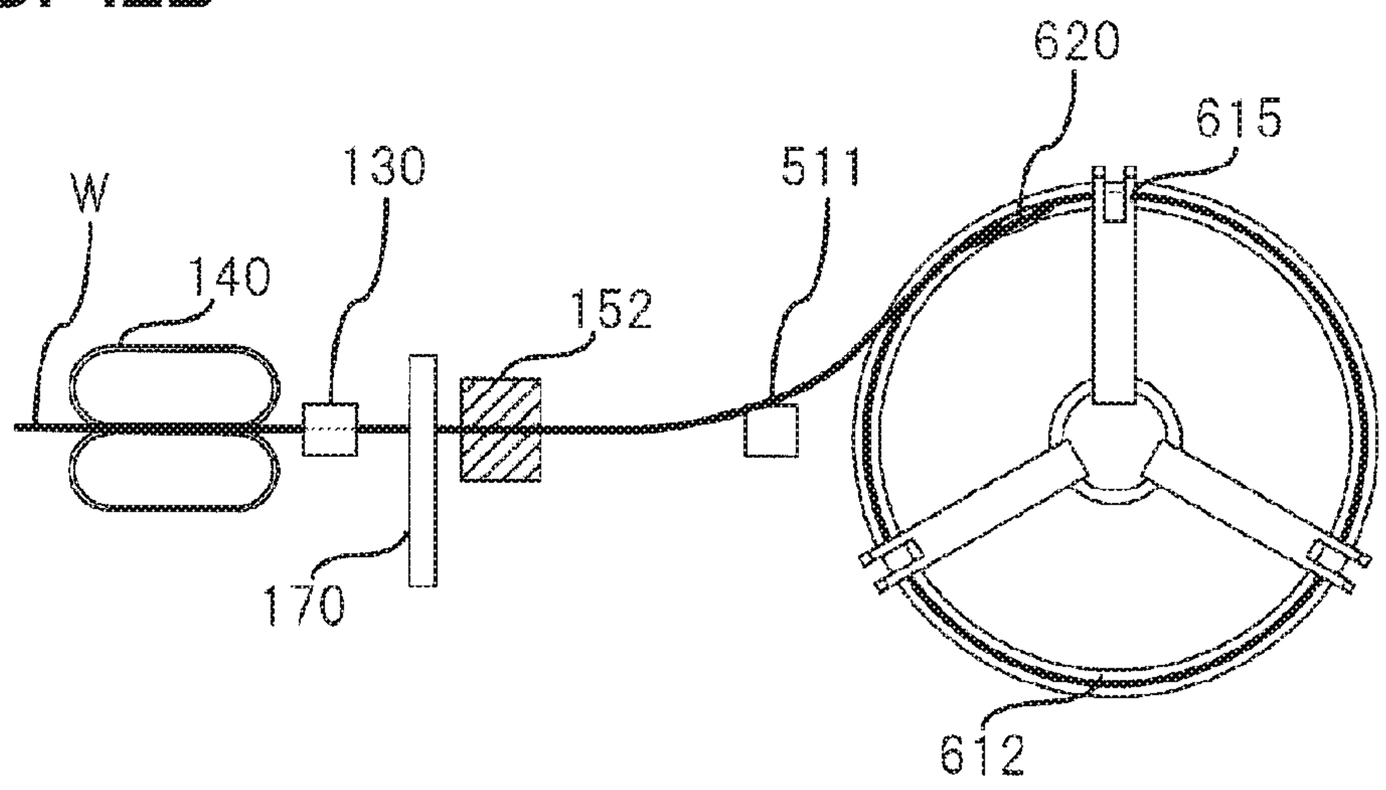


FIG. 43A

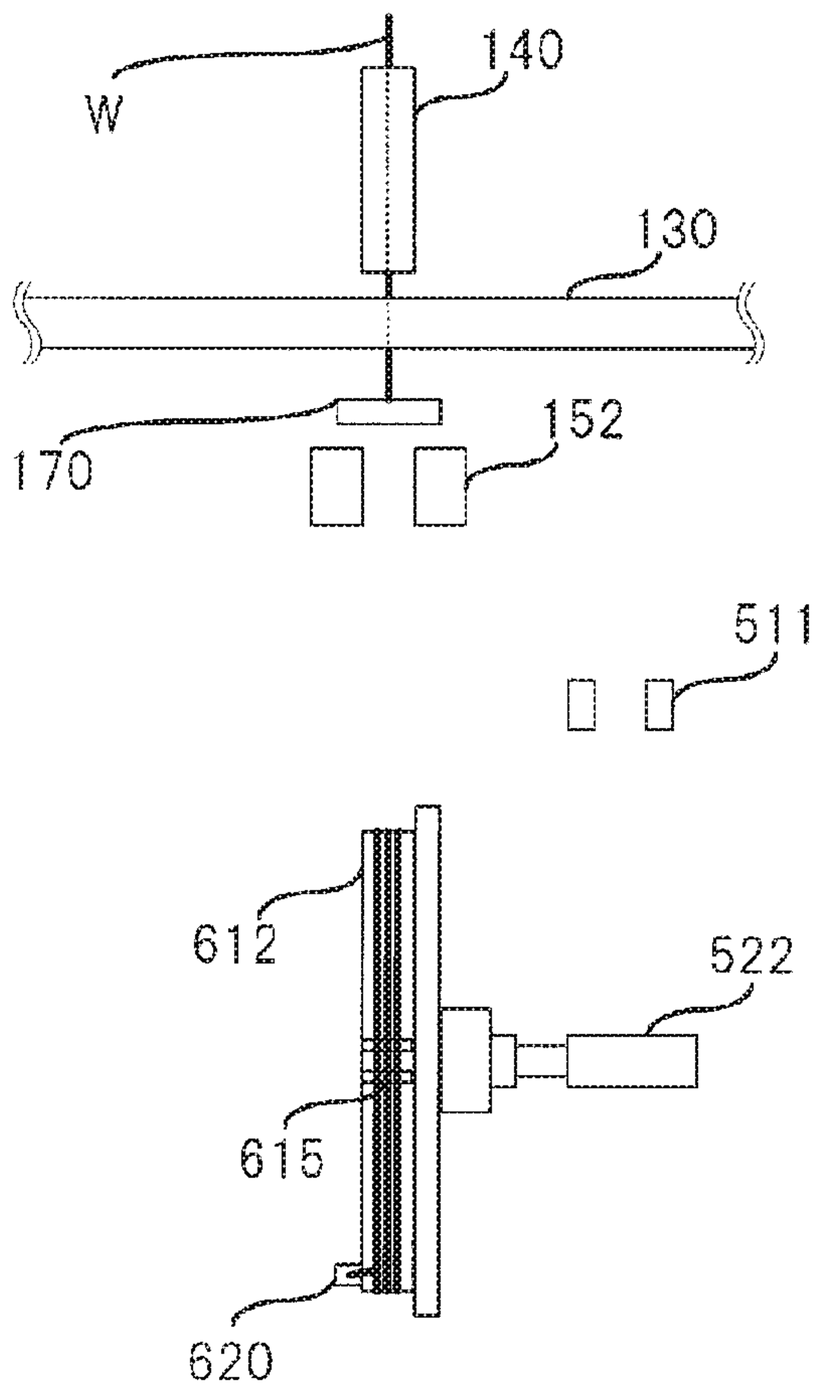
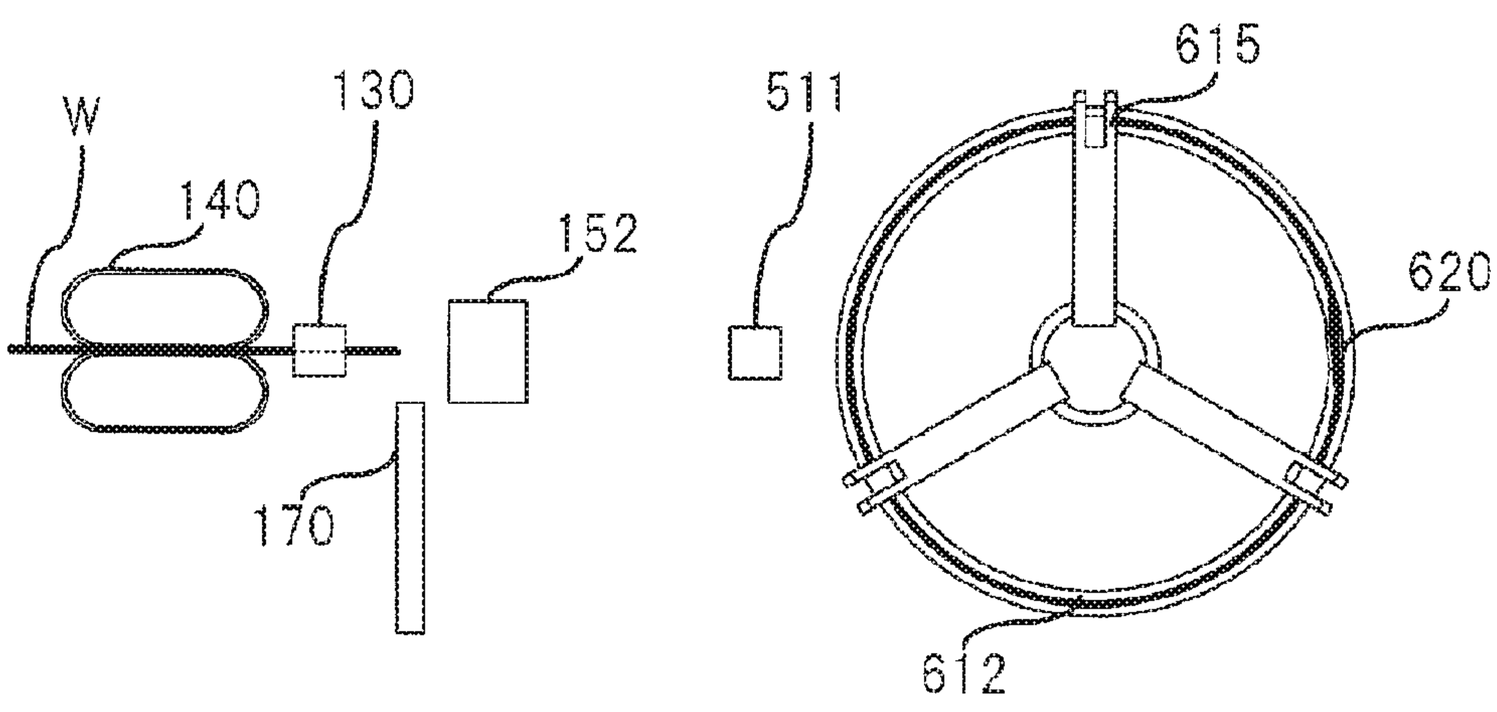


FIG. 43B



ELECTRIC WIRE PROCESSING APPARATUS, ELECTRIC WIRE PROCESSING METHOD, AND ELECTRIC WIRE HOLDING STRUCTURE

CROSS REFERENCE TO RELATED APPLICATION

This application is based on Japanese Patent Application No. 2017-043675 filed on Mar. 8, 2017, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to an electric wire processing apparatus and an electric wire processing method for processing an electric wire, and relates to an electric wire holding structure used in the electric wire processing apparatus and the electric wire processing method.

2. Background Art

In a process of processing an electric wire used for a wire harness, a technique for holding a plurality of electric wires in an electric wire holding bar is disclosed in JP-A-2010-92788. A technique for sequentially conveying a plurality of electric wire holding bars to a supply position of an electric wire with terminal is disclosed in JP-A-2010-287369 and JP-A-2013-152856.

Further, an electric wire sorting apparatus for sorting electric wires processed by an electric wire processing machine and an electric wire accommodating apparatus for accommodating electric wires after treatment with an electric wire processing apparatus are disclosed in JP-A-2012-104425 and JP-A-2011-216363.

In JP-A-2010-92788, JP-A-2010-287369, JP-A-2013-152856, JP-A-2012-104425, and JP-A-2011-216363 described above, a technique of manufacturing a wire harness is disclosed on the premise that an electric wire of a normal length of about 2 m is processed. In the case of manufacturing a wire harness using a long electric wire longer than the electric wire of a normal length, there is a process performed manually by a worker, and there is room for improving productivity in such a process.

An example of the above-described process performed manually is as follows. That is, a process of pulling the electric wire out of a reel and processing it into a long electric wire of a predetermined length is automatically performed in the related art, but the worker conveys the electric wire to an automatic machine, which performs the next process (stripping of a sheath, crimping of a terminal, or the like) of processing the electric wire. The worker winds the long electric wire in an annular shape and conveys it to the automatic machine with a shape and a size suitable for the conveyance.

The invention has been made in view of the above circumstances, and an object thereof is to provide an electric wire processing apparatus and an electric wire processing method which contribute to improvement in productivity in a case of conveying a long electric wire to an automatic machine for processing an electric wire, and to provide an electric wire holding structure used in the electric wire processing apparatus and the electric wire processing method.

SUMMARY OF THE INVENTION

in order to achieve the above-described object, an electric wire processing apparatus according to the invention is characterized by the following configurations (1) to (6),

(1) An electric wire processing apparatus includes:

a gripping mechanism that is capable of gripping a part of an electric wire;

a driving mechanism that drives the gripping mechanism;

an electric wire winding mechanism that winds the electric wire; and

a rotating mechanism that rotates and drives the electric wire winding mechanism, wherein

the electric wire winding mechanism includes

a winding drum on which the electric wire is wound,

an electric wire clip provided on the winding drum to hold a leading end of the electric wire, and

a holding member that holds an electric wire bundle wound around the winding drum in an annular shape,

the driving mechanism moves the gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip,

the rotating mechanism rotates the winding drum in a state where the leading end of the electric wire is held on the electric wire clip so that the electric wire is wound around the winding drum, and

the holding member holds the electric wire bundle wound around the winding drum in the annular shape.

(2) The electric wire processing apparatus of (1) further includes:

an electric wire cutting device that cuts the electric wire to a predetermined length and feeds the cut electric wire; and

an electric wire extracting device that receives the electric wire fed from the electric wire cutting device, wherein

the electric wire cutting device includes a first gripping mechanism serving as the gripping mechanism,

the electric wire extracting device includes a second gripping mechanism serving as the gripping mechanism, a second driving mechanism that drives the second gripping mechanism and serves as the driving mechanism, the electric wire winding mechanism, and the rotating mechanism,

the first gripping mechanism grips the leading end of the electric wire fed by the electric wire cutting device when the leading end is fed,

the second gripping mechanism grips the leading end and receives the electric wire when the first gripping mechanism grips the leading end of the electric wire, and

the second driving mechanism moves the second gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip.

(3) In the electric wire processing apparatus of (2),

the electric wire cutting device further includes a first driving mechanism that drives the first gripping mechanism and serves as the driving mechanism, and

the first driving mechanism drives the first gripping mechanism so that a direction of the leading end of the electric wire gripped by the first gripping mechanism is reversed from a forward feeding direction of the electric wire cutting device to a reverse feeding direction of the electric wire cutting device.

(4) In the electric wire processing apparatus of any one of (1) to (3),

the winding drum includes a hollow cylindrical body around which the electric wire is wound,

the cylindrical body is provided with a notch which is recessed downward in an axial direction of the cylindrical body from an upper end of the cylindrical body in the axial direction, and

the electric wire clip is accommodated and attached in the notch so that an electric wire pinching direction coincides with a radial direction of the cylindrical body.

(5) In the electric wire processing apparatus of (4),

the driving mechanism rotates the gripping mechanism, which grips the leading end of the electric wire, to be in a state where the leading end of the electric wire is inclined with respect to a plane orthogonal to the axial direction of the cylindrical body, and moves the gripping mechanism toward the electric wire clip.

(6) In the electric wire processing apparatus of (4),

the driving mechanism rotates the gripping mechanism, which grips the leading end of the electric wire, to be in a state where the electric wire pinching direction of the electric wire clip is orthogonal to a direction in which the leading end of the electric wire extends, and moves the gripping mechanism toward the electric wire clip.

In order to achieve the above-described object, an electric wire processing method according to the invention is characterized by the following configurations (7) and (11).

(7) An electric wire processing method includes:

moving a gripping mechanism, which grips a leading end of an electric wire, toward an electric wire clip for holding the leading end of the electric wire to hold the leading end on the electric wire clip;

rotating a winding drum, on which the electric wire clip is provided, in a state where the leading end of the electric wire is held on the electric wire clip so that the electric wire is wound around the winding drum; and

attaching a holding member to an electric wire bundle wound around the winding drum in the annular shape.

(8) The electric wire processing method of (7) further includes:

gripping the leading end of the electric wire fed by an electric wire cutting device, using a first gripping mechanism serving as the gripping mechanism included in the electric wire cutting device that cuts the electric wire to a predetermined length and feeds the cut electric wire, when the leading end is fed;

gripping the leading end and receives the electric wire, using a second gripping mechanism serving as the gripping mechanism included in an electric wire extracting device that receives the electric wire fed from the electric wire cutting device, when the first gripping mechanism grips the leading end of the electric wire; and

moving the second gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip.

(9) In the electric wire processing method of (8),

the first gripping mechanism is driven so that a direction of the leading end of the electric wire gripped by the first gripping mechanism is reversed from a forward feeding direction of the electric wire cutting device to a reverse feeding direction of the electric wire cutting device.

(10) In the electric wire processing method of any one of (7) to (9),

the winding drum includes a hollow cylindrical body around which the electric wire is wound, the cylindrical body is provided with a notch which is recessed downward in an axial direction from an upper end in the axial direction, and the electric wire clip is accommodated and attached in the notch, and

the gripping mechanism, which grips the leading end of the electric wire, is rotated to be in a state where the leading end of the electric wire is inclined with respect to a plane orthogonal to the axial direction of the cylindrical body, and the gripping mechanism is moved toward the electric wire clip.

(11) In the electric wire processing method of any one of (7) to (9),

the winding drum includes a hollow cylindrical body around which the electric wire is wound, the cylindrical body is provided with a notch which is recessed downward in an axial direction from an upper end in the axial direction, and the electric wire clip is accommodated and attached in the notch, and

the gripping mechanism, which grips the leading end of the electric wire, is rotated to be in a state where an electric wire pinching direction of the electric wire clip is orthogonal to a direction in which the leading end of the electric wire extends, and the gripping mechanism is moved toward the electric wire clip.

In order to achieve the above-described object, an electric wire holding structure according to the invention is characterized by the following configurations (12) and (13).

(12) An electric wire holding structure includes:

an electric wire; and

a holding member that holds an electric wire bundle, wherein

the electric wire is wound several times to form an annular shape, and is held by the holding member to maintain the annular shape.

(13) In the electric wire holding structure of (12),

the electric wire is held at three or more places by the holding member to maintain the annular shape.

According to the electric wire processing apparatus of the configuration (1), the electric wire processing method of the configuration (7), and the electric wire holding structure of the configuration (12), the electric wire is wound several times to form an annular shape, the electric wire is held at three or more places by the clamp, and thus the electric wire holding structure for maintaining the annular shape is completed. According to the electric wire holding structure for holding the electric wire, even in the case of manufacturing a wire harness using a long electric wire longer than a normal length, there is no need for the worker to deform the electric wire to have a shape and a size suitable for conveying the long electric wire to an automatic machine which processes the electric wire. Further, since the shape of the electric wire holding structure is maintained in the annular shape, the electric wire holding structure may be conveyed to the automatic machine for processing the electric wire by being hung on a hook, and thus the conveyance of the electric wire holding structure is also easily automated.

According to the electric wire processing apparatuses of the configurations (2) and (3) and the electric wire processing methods of the configurations (8) and (9), although existing equipment is used as the electric wire cutting device and a new equipment is used for the electric wire extracting device when the invention is performed, the invention c be applied to various electric wire cutting devices (existing equipment) when the electric wire extracting device processes the electric wire with the electric wire holding structure.

According to the electric wire processing apparatus of the configuration (4), when the electric wire clip holds the leading end of the electric wire, the leading end of the electric wire can be disposed in a state where the electric wire is wound side by side around the winding rib.

According to the electric wire processing apparatus of the configuration (5) and the electric wire processing method of the configuration (10), it is possible to maintain a state where a portion other than the leading end of the electric wire is located on the straight line through which the electric wire is fed by the electric wire feeding mechanism when the electric wire processing apparatus is viewed from the top. Thus, the position of the electric wire is prevented from being shifted every time the electric wire is wound around the winding drum.

According to the electric wire processing apparatus of the configuration (6) and the electric wire processing method of the configuration (11), the leading end of the electric wire can be easily pushed into the electric wire clip.

According to the electric wire holding structure of the configuration (13), when the electric wire bundle is held at a plurality of places, the electric wire can be maintained in an annular shape more similar to a circular shape.

According to the electric wire processing apparatus, the electric wire processing method, and the electric wire holding structure of the invention, it is possible to achieve an effect of contributing to productivity improvement in a case of conveying a long electric wire to an automatic machine.

The invention is briefly described above. Furthermore, the details of the invention will be further clarified by an embodiment to be described below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating an electric wire processing apparatus according to an embodiment of the invention;

FIG. **2** is a perspective view illustrating an electric wire cutting device according to the embodiment of the invention;

FIG. **3** is an enlarged perspective view illustrating a main part of the electric wire cutting device according to the embodiment of the invention;

FIG. **4** is a plan view of the electric wire cutting device according to the embodiment of the invention;

FIG. **5** is an enlarged plan view illustrating the main part of the electric wire cutting device according to the embodiment of the invention;

FIG. **6** is a perspective view illustrating an electric wire extracting device according to embodiment of the invention;

FIG. **7** is a perspective view illustrating of the electric wire extracting device according to embodiment of the invention as viewed from another angle;

FIG. **8** is a perspective view of a manipulator according to the embodiment of the invention;

FIG. **9** is a perspective view of an electric wire winding mechanism in which electric wires are wound in the electric wire extracting device according to the embodiment of the invention;

FIG. **10** is a perspective view of the electric wire winding mechanism in which electric wires are not wound in the electric wire extracting device according to the embodiment of the invention;

FIG. **11** is a perspective view an electric wire clip in the electric wire winding mechanism according to the embodiment of the invention;

FIG. **12** is a perspective view of a clamp in the electric wire winding mechanism according to the embodiment of the invention;

FIG. **13** is a perspective view of an electric wire holding structure according to the embodiment of the invention;

FIGS. **14**A and **14**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **15**A and **15**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **16**A and **16**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **17**A and **17**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **18**A and **18**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **19**A and **19**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **20**A and **20**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **21**A and **21**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **22**A and **22**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **23**A and **23**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **24**A and **24**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **25**A and **25**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **26**A and **26**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **27**A and **27**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **28**A and **28**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **29**A and **29**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **30**A and **30**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **31**A and **31**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **32**A and **32**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **33**A and **33**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **34**A and **34**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **35**A and **35**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **36**A and **36**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **37**A and **37**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **38**A and **38**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention:

FIGS. **39**A and **39**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **40**A and **40**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **41**A and **41**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention;

FIGS. **42**A and **42**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention; and

FIGS. **43**A and **43**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention.

DETAILED DESCRIPTION OF E EMBODIMENTS

A detailed embodiment of the invention will be described below with reference to each drawing.

Configuration of Electric Wire Processing Apparatus

FIG. **1** is a perspective view illustrating an electric wire processing apparatus according to the embodiment of the invention. An electric wire processing apparatus **1** according to the embodiment of the invention includes an electric wire cutting device **10** and an electric wire extracting device **50**. The electric wire cutting device **10** is a device that draws an electric wire from electric wires wound on a reel and supplies the electric wire cut to a predetermined length to the electric wire extracting device **50**. The electric wire extracting device **50** is a device that processes the electric wire of the predetermined length supplied from the electric wire cutting device **10** to have a shape and a size suitable for conveying to an automatic machine, which strips a sheath and crimps a terminal, using a manipulator to be controlled by a computer.

First, the electric wire cutting device **10** will be described in detail below with reference to FIGS. **2** to **5**. FIG. **2** is a perspective view illustrating an electric wire cutting device according to the embodiment of the invention. FIG. **3** is an enlarged perspective view illustrating a main part of the electric wire cutting device according to the embodiment of the invention. FIG. **4** is a plan view of the electric wire cutting device according to the embodiment of the invention. FIG. **5** is an enlarged plan view illustrating the main part of the electric wire cutting device according to the embodiment of the invention.

The electric wire cutting device **10** is configured in which a first electric wire guide **110**, a second electric wire guide **120**, a third electric wire guide **130**, an electric wire feeding mechanism **140**, an electric wire gripping mechanism **150**, a rotating mechanism **160**, and an electric wire cutting mechanism **170** are fixed to a support frame **180**.

The first electric wire guide **110** is a member that guides electric wires wound on a reel (not illustrated), which is disposed adjacent to the electric wire cutting device **10**, to the electric wire cutting device **10**. As illustrated in FIG. **2**, the first electric wire guide **110** has a structure in which a plurality of disk members **111** having grooves formed along a circumferential direction are fixed to the support frame **180**. The plurality of disk members **111** is disposed in a line so that adjacent grooves are aligned in parallel. The electric wire wound on the reel is drawn toward one of the plurality of disk members **111** and is guided to the groove of the disk member **111**, thereby being disposed toward the electric wire cutting device **10**.

The second electric wire guide **120** is a member that guides the electric wire guided by the first electric wire guide **110** toward the electric wire feeding mechanism **140**. As illustrated in FIGS. **2** and **3**, the second electric wire guide **120** includes a bar-shaped guide body **121** having a rectangular cross-section that is fixed to the support frame **180** in a direction substantially parallel to the direction in which the disk member **111** of the first electric wire guide **110** is disposed. The guide body **121** is formed with a plurality of guide holes **122** penetrating through the guide body **121**. The guide hole **122** is perforated in the guide body **121** in a direction substantially perpendicular to a longitudinal direction of the guide body **121**. The electric wire guided by the first electric wire guide **110** is inserted into the guide hole **122** and is guided to the guide hole **122**, thereby being disposed toward the electric wire feeding mechanism **140**.

The third electric wire guide **130** is a member that guides the electric wire guided by the second electric wire guide **120** toward the electric wire gripping mechanism **150**. As illustrated in FIGS. **2** and **3**, the third electric wire guide **130** includes a bar-shaped guide body **131** having a rectangular cross-section that is fixed to the support frame **180** in a direction substantially parallel to the longitudinal direction of the guide body **121** of the second electric wire guide **120**. The guide body **131** is formed with a plurality of guide holes **132** penetrating through the guide body **131**. The guide hole **132** is perforated in the guide body **131** in a direction substantially perpendicular to the longitudinal direction of the guide body **131**. The electric wire guided by the second electric wire guide **120** is inserted into the guide hole **132** and is guided to the guide hole **132**, thereby being disposed toward the electric wire gripping mechanism **150**. In addition, each of the guide holes **132** is provided at a position facing each of the guide holes **122** of the second electric wire guide **120**. Therefore, the electric wire located between the second electric wire guide **120** and the third electric wire guide **130** is disposed substantially perpendicular to the second electric wire guide **120** and the third electric wire guide **130**.

The electric wire feeding mechanism **140** is a mechanism that feeds the electric wire toward the direction in which the electric wire gripping mechanism **150** is located, that is, toward a direction opposite to the first electric wire guide **110** in the electric wire cutting device **10**. Specifically, as illustrated in FIG. **3**, the electric wire feeding mechanism **140** includes an upper belt drive **141** configured with one annular belt **142** and a plurality of pulleys **143** meshed with an inner circumferential surface of the belt **142** and a lower belt drive **144** configured with one belt **145** and a plurality of pulleys **146** meshed with an inner circumferential surface of the belt **145**. The upper belt drive **141** and the lower belt drive **144** are arranged such that a part of the belt **142** and a part of the belt **145** are in contact with each other and the contacting part is disposed between the second electric wire guide **120** and the third electric wire guide **130** and on a segment between the guide hole **122** and the guide hole **132** facing each other. Therefore, the electric wire feeding mechanism **140** can pinch the electric wire located between

the second electric wire guide **120** and the third electric wire guide **130** at the contacting part between the belt **142** and the belt **145**. The electric wire feeding mechanism **140** drives the upper belt drive **141** and the lower belt drive **144** to revolve them in opposite directions in a state where the electric wire is pinched, so that the electric wire can be fed in the direction in which the electric wire gripping mechanism **150** is located.

The electric wire gripping mechanism **150** is a member (may be referred to as a gripping mechanism) that grips a part of the electric wire guided by the third electric wire guide **130** and fed from the third electric wire guide **130**. Specifically, as illustrated in FIG. **3**, the electric wire gripping mechanism **150** includes a first chuck **151** located at a front side in the direction in which the electric wire is fed (hereinafter, may be referred to as a feeding direction) and a second chuck **152** located at a rear side in the feeding direction. Each of the first chuck **151** and the second chuck **152** includes a contact surface for gripping the electric wire at the front of the guide hole **132** of the third electric wire guide **130**. For this reason, the electric wire gripping mechanism **150** can grip the electric wire guided and fed by the third electric wire guide **130** with the first chuck **151** and the second chuck **152**.

The rotating mechanism **160** is a mechanism (may be referred to as a driving mechanism) that converts a leading end of the electric wire guided by the third electric wire guide **130** and extending in a forward feeding direction to a reverse feeding direction. Specifically, as illustrated in FIGS. **3** and **4**, the rotating mechanism **160** is connected to the first chuck **151** of the electric wire gripping mechanism **150**, and can rotate the first chuck **151** by 180 degrees around a rotation axis P set apart from the first chuck **151** by a predetermined distance. As will be described in detail below, when the rotating mechanism **160** rotates the first chuck **151**, which is in the state of gripping the electric wire, by 180 degrees (at this time, the second chuck **152** does not grip the electric wire), the direction of the leading end of the electric wire gripped by the first chuck **151** is changed from the forward feeding direction toward the reverse feeding direction.

The electric wire cutting mechanism **170** is a mechanism that cuts the electric wire guided by the third electric wire guide **130** and fed from the third electric wire guide **130**. Specifically, the electric wire cutting mechanism **170** includes a V-shaped lower blade having an opening, which faces upward, and moving upward. The lower blade is disposed between the third electric wire guide **130** and the electric wire gripping mechanism **150**. When the electric wire is fed from the third electric wire guide **130**, the lower blade is disposed separately from the third electric wire guide **130**. For this reason, the electric wire to be fed passes above the lower blade and advances toward the first chuck **151** and the second chuck **152** in the electric wire gripping mechanism **150**. On the other hand, when the electric wire fed from the third electric wire guide **130** is cut, the lower blade approaches the third electric wire guide **130**. Therefore, when the lower blade is separated from third electric wire guide **130**, the electric wire passing above the lower blade is cut by the approach of the lower blade.

The support frame **180** is a frame that is used to fix the first electric wire guide **110**, the second electric wire guide **120**, the third electric wire guide **130**, the electric wire feeding mechanism **140**, the electric wire gripping mechanism **150**, the rotating mechanism **160**, and the electric wire cutting mechanism **170** at predetermined positions.

Although an example of the electric wire cutting device **10** is described with reference to FIGS. **2** to **5**, the electric wire processing apparatus, the electric wire processing method, and the electric wire holding structure according to the invention are not limited by the mechanisms of the electric wire cutting device **10**.

Subsequently, the electric wire extracting device **50** will be described in detail below with reference to FIGS. **6** to **12**. FIG. **6** is a perspective view illustrating the electric wire extracting device according to the embodiment of the invention. FIG. **7** is a perspective view of the electric wire extracting device according to the embodiment of the invention as viewed from another angle. FIG. **8** is a perspective view of a manipulator in the electric wire extracting device according to the embodiment of the invention. FIG. **9** is a perspective view of the electric wire winding mechanism, in which the electric wires are wound, in the electric wire extracting device according to the embodiment of the invention. FIG. **10** is a perspective view of a manipulator in the electric wire extracting device according to the embodiment of the invention. FIG. **9** is a perspective view of the electric wire winding mechanism, in which the electric wires are not wound, in the electric wire extracting device according to the embodiment of the invention. FIG. **11** is a perspective view of an electric clip in the electric wire winding mechanism according to the embodiment of the invention. FIG. **12** is a perspective view of a clamp in the electric wire according to the embodiment of the invention. FIG. **13** is a perspective view of an electric wire holding structure according to the embodiment of the invention.

The electric wire extracting device **50** includes a manipulator **510**, an electric wire winding mechanism **520**, and a clamp storage shelf **530** which are fixed to a support frame **540**.

The manipulator **510** is a mechanism that receives the electric wire cut to a predetermined length form the electric wire cutting device **10** and delivers the electric wire to the electric wire winding mechanism **520**. Specifically, as illustrated in FIG. **8**, the manipulator **510** is a robot arm with three degrees of freedom. A claw-type hand **511** (may be referred to as a gripping mechanist is provided at a tip end of the manipulator **510**, while a base frame is attached to the support frame **540**. Motors **512** provided in three joints of the manipulator **510** are driven, and thus the hand **511** can move to an arbitrary position with an arbitrary angle in a working space (hereinafter, the motor **512** may be referred to as a driving mechanism). Although will be described in detail below, the manipulator **510** moves the hand **511** to grip the electric wire gripped by the electric wire gripping mechanism **150** of the electric wire cutting device **10** with the hand **511** and to receive the electric wire, and moves the hand **511** in a state of gripping the electric wire to deliver the electric wire to the electric wire winding mechanism **520**. Thereafter, the manipulator moves the hand **511** again to the electric wire gripping mechanism **150**, and repeatedly performs a series of operations of receiving and delivering with the hand **511**.

The electric wire winding mechanism **520** is a mechanism that receives the electric wire supplied from the manipulator **510** and processes a long electric wire to have a shape and a size suitable for conveying to an automatic machine which processes the electric wire. Schematically, as illustrated in FIGS. **6** and **7**, the electric wire winding mechanism **520** is a mechanism in which a torque of a motor **522** is transmitted to a disk-shaped winding drum **521** by a pulley **523** and a belt **524** and a rotating shaft **525** rotates, whereby the winding drum **521** rotates. When the winding drum **521**

rotates, as illustrated in FIG. **9**, the electric wire is wound around the winding drum **521**.

A detailed structure of the winding drum **521** will be described with reference to FIGS. **9** and **10**. As illustrated in FIG. **10**, the winding drum **521** is based on a base frame **611**. The base frame **611** has a flat circular shape and is formed with a hole at the center, and the above-described rotating shaft **525** penetrates through the base frame **611**. The base frame **611** is provided with a cylindrical winding rib **612** protruding from one surface of the base frame **611** so as to revolve along an edge of the base frame **611**. The winding rib **612** has a notch **613** recessed downward in the axial direction from an upper end in the axial direction. An electric wire clip **620**, which grips the leading end of the electric wire, is accommodated and attached in the notch **613**. The electric wire clip **620** will be described below.

In addition, the winding drum **521** traverses the winding rib **612** by extending outwardly in a radial direction of the base frame **611** from the center of the base frame **611**, and has three bar-shaped connection bodies **614** protruding from an outer circumferential surface (a surface being in contact with the electric wire to be wound) of the winding rib **612**. The connection body **614** includes an end located at the center of the base frame **611** and connected to the above-described rotating shaft **525** and an end located at an edge of the base frame **611** and connected to the base frame **611**. The three connection bodies **614** are disposed at an equal angle (120 degrees) when viewing one surface, on which the winding rib **612** of the base frame **611** is provided, from the front. The base frame **611** is connected to the above-described rotating shaft **525** via the three connection bodies **614**, so that the winding drum **521** rotates as the rotating shaft **525** rotates.

Further, the connection body **614** is characterized by the shape of the end located at the edge of the base frame **611**. That is, two guide plates **615** extending in a direction orthogonal to the revolving direction of the winding rib **612** are provided at the end of one connection body **614** so as to face each other with a distance therebetween. In addition, one guide plate **615** is configured in which a large protruding piece **616**, a small protruding piece **617**, and a middle protruding piece **618** are arranged in a protruding direction of the winding rib **612** at a position protruding from an outer circumferential surface (a surface being in contact with the electric wire to be wound) of the winding rib **612**. The large protruding piece **616** has the largest protruding length from the outer circumferential surface of the winding rib **612**, the middle protruding piece **618** has a second-largest protruding length from the outer circumferential surface of the winding rib **612**, and the small protruding piece **617** is the smallest protruding length from the outer circumferential surface of the winding rib **612**. For this reason, a recess portion **619** is formed to be sandwiched between both sides of the large protruding piece **616** and the middle protruding piece **618** at the position protruding from outer circumferential surface of the winding rib **612**. As illustrated in FIG. **10**, the recess portion **619** plays a role of guiding the electric wire wound around the winding rib **612**, so that the electric wire wound around the winding rib **612** gathers in the recess portion **619**, thereby forming an annular electric wire bundle. In addition, a clamp **630** is accommodated in a space S formed between two guide plates **625** facing each other in the connection body **614**. The clamp **630** will be described below.

The electric wire clip **620** is a structure body that receives the electric wire from the manipulator **510** and pinches the leading end of the electric wire. As the electric wire clip **620** holds the leading end of the electric wire, the leading end of the electric wire is attached to the winding drum **521**, whereby the electric wire can be wound around the winding rib **612** when the winding drum **521** rotates. As illustrated in FIG. **11**, the electric wire clip **620** has a structure in which a pair of pinching elements **621** for pinching the electric wire is fixed to a mounting base **622**. The pair of pinching elements **621** are configured in which a pushing direction (height direction) of the article to be pinched into the pinching element **621** extends longer than a pinching direction (width direction) and a thickness direction (depth direction) of the article to be pinched. When the electric wire clip **620** is attached to the winding drum **521**, the mounting base **622** is accommodated and fixed into the notch **613** so that the height direction of the pair of pinching elements **621** coincides with the protruding direction of the winding rib **612**, and the depth direction thereof coincides with the circumferential direction of the winding rib **612**. As a result of the fixation in this way, the pinching direction (width direction) of the article to be pinched between the pair of pinching element **621** coincides with the radial direction of the winding rib **612**. The electric wire clip **620** is attached to the notch **613** in this way, and thus, as illustrated in FIG. **9**, when the electric wire clip **620** holds the leading end of the electric wire, the leading end of the electric wire can be disposed in a state where the electric wire is wound side by side around the winding rib **612**.

The clamp **630** is a holding member that holds the annular electric wire bundle formed in a bundle by the winding of one electric wire. As illustrated in FIG. **12**, the clamp **630** includes a box-shaped support frame **631** and a pair of flippers **632** in which one end thereof is rotatably supported on the support frame **631** and the other includes a bulging portion **633** which is bulged. The pair of flippers **632** can take a closed state in which the bulging portions **633** are in contact with each other and an open state in which the bulging portions are separated from each other and are opened. An elastic member such as a spring is connected to the pair of flippers **632**, and the bulging portions **633** are maintained in the closed state of being in contact with each other by an elastic force due to the elastic member. When the pair of flippers **632** are in the closed state, a space T surrounded by a lower end of the support frame **631** and an inner side surfaces of the pair of flippers **632** is formed in the clamp **630**. As illustrated in FIG. **9**, the clamp **630** accommodates the annular electric wire bundle formed in a bundle by the winding of one electric wire and holds the electric wire. When the annular electric wire bundle is accommodated in the space T, the pair of flippers **632** are opened while the electric wire bundle is pressed against the pair of flippers **632** being in the closed state in the vicinity of a contact point where the bulging portions **633** are in contact with each other, and the electric wire bundle slides into the space T as it is. In order to easily accommodate the electric wire bundle in the space T, the pair of flippers **632** have a tapered shape such that the outer side surface of the bulging portion **633** gradually widens as a distance increases from contact point where the bulging portions **633** are in contact with each other.

As illustrated in FIG. **9**, three clamps **630** are attached to the annular electric wire bundle wound around the winding rib **612** to hold the electric wire bundle. At this time, each of the clamps **630** is accommodated in the space S formed between two guide plates **615**. For this reason, the two guide plates **615** are separated by a distance slightly longer than a thickness of the clamp **630**. After the three clamps **630** are respectively inserted into three spaces S to hold the annular electric wire bundle at three points3, the leading end of the

electric wire is detached from the electric wire clip **620** and the annular electric wire bundle is removed from the winding rib **612**. At this time, the annular electric wire bundle is slid in the protruding direction of the winding rib **612** with respect to the winding rib **612** and removed from the winding rib **612**, but the electric wire bundle is slid over the middle protruding piece **618** of the guide plate **615** at that time. Conversely, the middle protruding piece **618** has a height such that the electric wire bundle can get over when the annular electric wire bundle is removed from the winding rib **612**. The annular electric wire bundle removed from the winding rib **612** in this way is illustrated in FIG. **13**. As illustrated in FIG. **13**, the clamps **630** holds three points of the electric wire bundle formed in an annular shape by the winding of one electric wire, and thus the annular electric wire bundle is maintained in a state of the annular shape. A structure including the electric wire and the clamps **630** is referred to as an electric wire holding structure **700** in which three points of the annular electric wire bundle formed in the annular shape by a several winding of one electric wire WT are held by the clamps **630** and the electric wire is maintained in the annular shape. The electric wire winding mechanism **520** is described above.

The clamp storage shelf **530** is a shelf in which the clamp **630** is stored. As illustrated in FIGS. **6** and **7**, a plurality of clamps **630** is loaded in a thickness direction in the clamp storage shelf **530**.

The support frame **540** is a frame that is used to fix the manipulator **510**, the electric wire winding mechanism **520**, and the clamp storage shelf **530** at predetermined positions.

Operation of Electric Wire Processing Apparatus

The configuration of the electric wire processing apparatus according to the embodiment of the invention is described in detail above. Hereinafter, an operation of the electric wire processing apparatus according to the embodiment of the invention will be described in detail.

First Example of Operation of Electric Wire Processing Apparatus

FIGS. **14**A and **14**B to FIGS. **30**A and **30**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention. "A" in the drawings is a plan view schematically illustrating a main part relating to the operation of the electric wire processing apparatus **1** when the electric wire processing apparatus **1** is seen from the top. "B" in the drawings is a side view schematically illustrating the main part relating to the operation of the electric wire processing apparatus **1** when the electric wire processing apparatus **1** is seen from the side. FIGS. **14**A and **14**B to FIGS. **30**A and **30**B illustrate a series of processes in which the electric wire processing apparatus **1** processes one electric wire W, and each of the drawings depicts one operation in this series of processes. After this series of processes is performed by the electric wire processing apparatus **1**, as illustrated in FIGS. **14**A, **14**B, and **30**A, the electric wire holding structure **700** including the electric wire W and the clamp **630** is completed in which three points of an annular electric wire bundle C formed in an annular shape by a several winding of one electric wire W are held by the clamps **630** and the electric wire is maintained in the annular shape. The operation of the electric wire processing apparatus **1** will be described below.

After the previous series of processes is completed by the electric wire processing apparatus **1**, as illustrated in FIGS. **14**A and **14**B, the leading end of the electric wire W cut by the electric wire cutting mechanism **170** of the electric wire cutting device **10** in the previous series of processes is in a state of staying on the electric wire cutting mechanism **170**. Further, the winding rib **612** of the electric wire winding mechanism **520** in the electric wire extracting device **50** is disposed in front of the electric wire feeding mechanism **140** of the electric wire cutting device **10**, whereby the winding rib **612** is located on a straight line through which the electric wire feeding mechanism **140** feeds the electric wire W.

First, as illustrated in FIGS. **15**A and **15**B, the electric wire feeding mechanism **140** feeds the electric wire W to the extent that the leading end of the electric wire W passes through the first chuck **151** and the second chuck **152** of the electric wire gripping mechanism **150**. The number of rotations of the pulley **143** and the pulley **146** is counted when the electric wire W is fed, whereby a length L**1** of the electric wire W fed by the operation illustrated in FIGS. **15**A and **15**B is measured.

Subsequently, as illustrated in FIGS. **16**A and **16**B, the first chuck **151** of the electric wire gripping mechanism **150** is closed to grip the electric wire W. In FIG. **16**B, the closed state of the first chuck **151** is represented by hatching in the range indicating the first chuck **151**.

Subsequently, as illustrated in FIGS. **17**A and **179**, the rotating mechanism **160** rotates the first chuck **151** by 180 degrees in a clockwise direction around the rotation axis P. As the first chuck **151** rotates, the electric wire feeding mechanism **140** feeds the electric wire W. Additionally, a length L**2** of the electric wire W fed by the operation illustrated in FIGS. **17**A and **179** is also measured. At this time, the length L**2** of the electric wire W fed by the electric wire feeding mechanism **140** is shorter than a total extension of the annular electric wire W illustrated in FIGS. **13** and **30**A, and preferably has a length to the extent that the electric wire W suspended by its own weight floats in the air without being in contact with the installation surface of the electric wire processing apparatus **1** as illustrated in FIG. **17**B. When the rotating mechanism **160** rotates the first chuck **151**, which is in the state of gripping the electric wire, by 180 degrees, the direction of the leading end of the electric wire gripped by the first chuck **151** is changed to the reverse feeding direction from the forward feeding direction. In this way, the electric wire W is fed after the first chuck **151** is reversed, and thus the first chuck **151** is moved to a position where feeding of the electric wire W with the electric wire feeding mechanism **140** is not disturbed. Further, when the direction of the leading end of the electric wire W is reversed, it is not necessary for the hand **511** to reverse the leading end of the electric wire W when the hand **511** inserts the leading end of the electric wire W into the electric wire clip **620** in the operation to be described below with reference to FIGS. **21**A and **21**B, and the movement of the hand **511** can be suppressed.

Subsequently, as illustrated in FIGS. **18**A and **18**B, the manipulator **510** moves the hand **511** adjacently to the electric wire winding mechanism **520** of the first chuck **151**, and the hand **511** grips the electric wire gripped by the first chuck **151**. In FIG. **18**B, the closed state of the hand **511** is represented by hatching in the range indicating the hand **511**.

Subsequently, as illustrated in FIGS. **19**A and **19**B, the first chuck **151** of the electric wire gripping mechanism **150** is opened to release the gripped electric wire W.

Subsequently, as illustrated in FIGS. **20**A and **20**B, the manipulator **510** moves the hand **511** to a position adjacent to the winding rib **612** and opposite to the side where the electric wire cutting device **10** is located. At this time, the

hand **511** is located on the straight line through which the electric wire W is fed by the electric wire feeding mechanism **140** when the electric wire processing apparatus **1** is viewed from the top as illustrated in FIG. **20**A, and is located at substantially the same height as the height at which the electric wire clip **620** is located when the electric wire processing apparatus **1** is viewed from the side as illustrated in FIG. **20**B. Further, as the hand **511** moves, the electric wire feeding mechanism **140** feeds the electric wire W. Additionally, a length L**3** of the electric wire W fed by the operation illustrated in FIGS. **20**A and **20**B is also measured. By the operation of the hand **511** and the electric wire feeding mechanism **140**, the electric wire W from the electric wire feeding mechanism **140** to the hand **511** is located on the straight line through which the electric wire W is fed by the electric wire feeding mechanism **140** when the electric wire processing apparatus **1** is viewed from the top as illustrated in FIG. **20**A, and the electric wire W extending from the hand **511** descends toward the lower side (a downward side in FIG. **20**B) of the winding rib **612** so as to bypass the winding rib **612** when the electric wire processing apparatus **1** is viewed from the side as illustrated in FIG. **20**B and ascends toward the electric wire feeding mechanism **140** from the moment of passing a position just below the winding rib **612**. With such a positional relation of the electric wire W, the electric wire W wound around the winding rib **612** can be easily collected in the recess portion **619** of the guide plate **615** when the electric wire W is wound around the winding rib **612** by the subsequent operation.

Subsequently, as illustrated in FIGS. **21**A and **21**B, the manipulator **510** moves the hand **511** adjacently to the electric wire clip **620** provided on the winding drum **521**, and thus the leading end of the electric wire W gripped by the hand **511** is pushed between the pair of pinching elements **621** of the electric wire clip **620**. At this time, as illustrated in FIG. **21**A, the hand **511** is rotated in a yaw direction, and thus a part of the leading end of the electric wire W partially protrudes to the side opposite to the base frame **611** of the winding rib **612**. In this way, the hand **511** is moved toward the electric wire clip **620** in a state where the hand **511** is moved in the yaw direction and thus the leading end of the electric wire W is inclined with respect to a plane orthogonal to the axial direction of the winding rib **612**, whereby it is possible to maintain a stale where a portion other than the leading end of the electric wire W is located on the straight line through which the electric wire W is fed by the electric wire feeding mechanism **140** when the electric wire processing apparatus **1** is viewed from the top as illustrated in FIG. **21**A. That is, the position of the electric wire is prevented from being shifted every time the electric wire is wound around the winding drum **521**. Further, as illustrated in FIG. **21**B, the hand **511** is rotated in a pitch direction so that the depth direction of the electric wire clip **620** corresponding to the position of the electric wire clip **620** coincides with the direction in which the leading end of the electric wire W extends (in other words, the pinching direction of the article to be pinched between the pair of pinching elements **621** of the electric wire clip **620** is orthogonal to the direction where the leading end of the electric wire W extends). In this way, the hand **511** is moved toward the electric wire clip **620** in the state where the hand **511** is rotated in the pitch direction and thus the pinching direction between the pair of pinching elements **621** is orthogonal to the direction where the leading end of the electric wire W extends, so that the leading end of the electric wire W can be easily pushed between the pinching elements **621** of the electric wire clip **620**. When the leading end of the electric wire W is pushed between the pinching elements **621** of the electric wire clip **620**, the manipulator **510** moves the hand **511** once to the left side from the electric wire clip **620** in FIG. **21**A, and then the leading end of the electric wire W is pushed between the pinching elements **621** of the electric wire clip **620** using the momentum that the hand **511** moves to the right side toward the electric wire clip **620**. When the hand **511** comes in to contact with the winding rib **612** in the case where the hand **511** moves toward the electric wire clip **620**, since the contact place between the hand **511** and the winding rib **612** is determined according to the position of the electric wire clip **620**, a notch is provided at a predetermined contact place to cope with the contact between the hand **511** and the winding rib **612**. A jig may be formed on the hand **511** to spread out the pinching element **621** of the electric wire clip **620**, and the leading end of the electric wire W may be accommodated inside the pinching element **621** which is spread out.

Subsequently, as illustrated in FIGS. **22**A and **22**B, the manipulator **510** opens the hand **511** to release the electric wire W which is gripped.

Subsequently, as illustrated in FIGS. **23**A and **23**B, the manipulator **510** moves the hand **511** to an initial position.

Subsequently, as illustrated in FIGS. **24**A and **24**B, the electric wire winding mechanism **520** drives the motor **522** to rotate the winding drum **521**. The winding drum **521** rotates counterclockwise in FIG. **24**B. During the operation illustrated in FIGS. **24**A and **24**B, the electric wire feeding mechanism **140** does not feed the electric wire W, so that the electric wire W slackened under the winding rib **612** is wound around the winding rib **612** by the rotation of the winding drum **521**. In this way, as illustrated in FIGS. **25**A and **25**B, the electric wire feeding mechanism **140** does not feed the electric wire W until the electric wire W comes in contact with the lower end of the winding rib **612**, and the electric wire W is wound around the winding rib **612**.

Subsequently, as illustrated in FIGS. **26**A and **26**B, the electric wire winding mechanism **520** drives the motor **522** to rotate the winding drum **521**. During the operation illustrated in FIGS. **26**A and **269**, the electric wire feeding mechanism **140** feeds the electric wire W. A length L**4** of the electric wire W fed by the operation illustrated in FIGS. **26**A and **26**B is also additionally measured. At this time, the electric wire feeding mechanism **140** controls the amount of electric wire W to be fed and the electric wire winding mechanism **520** controls the number of rotations of the winding drum **521** such that the length of the electric wire W fed by the electric wire feeding mechanism **140** per time is equal to the length of the electric wire W wound around the outer circumferential surface of the winding rib **612** per time. FIGS. **26**A and **26**B illustrate a state in which the winding drum **521** rotates several times and the electric wire W is wound around the winding rib **612** several times. Thereafter, when the total value of the lengths (L**1**, L**2**, L**3**, and L**4**) of the electric wire fed in four operations reaches a predetermined length, the electric wire feeding mechanism **140** stops the feeding of the electric wire W, and the electric wire winding mechanism **520** stops the rotation of the winding drum **521**.

Subsequently, as illustrated in FIGS. **27**A and **27**B, the second chuck **152** of electric wire gripping mechanism **150** is closed to grip the electric wire W. Subsequently, the lower blade of the electric wire cutting mechanism **170** approaches the third electric wire guide **130** to cut the electric wire W.

Subsequently, as illustrated in FIGS. **28**A and **28**B, the second chuck **152** of the electric wire gripping mechanism **150** is opened to release the gripped electric wire W. Subsequently, the electric wire winding mechanism **520** drives the motor **522** to rotate the winding drum **521**. Next, the rotating mechanism **160** rotates the first chuck **151** by 180 degrees in a counterclockwise direction around the rotation axis P. During the operation illustrated in FIGS. **28**A and **289**, the electric wire feeding mechanism **140** does not feed the electric wire W. The other end of the electric wire W gripped by the second chuck **152** of the electric wire gripping mechanism **150** in FIGS. **27**A and **27**B is wound around the winding rib **612** by the rotation of the winding drum **521**. Thus, as illustrated in FIGS. **28**A and **28**B, the total extension length of the electric wire W cut into a predetermined length is wound around the winding rib **612**.

Subsequently, as illustrated in FIGS. **29**A and **29**B, three clamps **630** are attached to the annular electric wire bundle C wound around the winding rib **612**. At this time, the clamp **630** is accommodated in the space S formed between the guide plates **615**.

Subsequently, as illustrated in FIGS. **30**A and **30**B, the leading end of the electric wire is detached from the electric wire clip **620** and the annular electric wire bundle C is removed from the winding rib **612**. At this time, the annular electric wire bundle C is slid in the protruding direction of the winding rib **612** with respect to the winding rib **612** and removed from the winding rib **612**. As illustrated in FIGS. **13** and **30**A, the clamps **630** holds three points of the electric wire bundle C formed in an annular shape by the winding of one electric wire, and thus the annular electric wire bundle C is maintained in a state of the annular shape.

As described above with reference to FIGS. **14**A to **30**B, the electric wire processing apparatus according to the embodiment of the invention processes one electric wire W into the electric wire holding structure **700**. According to the electric wire holding structure **700**, even in the case of manufacturing a wire harness using a long electric wire longer than a normal length, there is no need for the worker to deform the electric wire to have a shape and a size suitable for conveying the long electric wire to an automatic machine which processes the electric wire. Further, since the shape of the electric wire holding structure **700** is maintained in the annular shape, the electric wire holding structure **700** may be conveyed to the automatic machine for processing the electric wire by being hung on a hook, and thus the conveyance of the electric wire holding structure **700** is also easily automated. Thus, according to the electric wire processing apparatus and the electric wire processing method of the embodiment of the invention, and the electric wire holding structure used in the electric wire processing apparatus and the electric wire processing method, it is possible to obtain an excellent effect of contributing to improvement in productivity when the long electric wire is conveyed to the automatic machine for processing the electric wire.

The clamp **630** is used to maintain the annular shape of the electric wire bundle C in the example described above, but the invention is not limited to the case where the annular electric wire bundle C is held by the clamp **630**. For example, instead of the clamp **630**, a tape may be wound around the electric wire bundle C to maintain the shape of the electric wire bundle C in an annular shape. Briefly, various members can be applied to maintain the shape of the electric wire bundle C in an annular shape.

Further, three clamps **630** are used to maintain the annular shape of the electric wire bundle C in the example described above, but the invention is not limited to the case where the electric wire bundle C is held at three places. Even when the electric wire bundle C is held at one place, the electric wire bundle C can be maintained in an annular shape. On the other hand, when the electric wire bundle C is held at a plurality of places, the electric wire bundle C can be maintained in an annular shape more similar to a circular shape.

Second Example of Operation of Electric Wire Processing Apparatus

In the "first example of the operation of the electric wire processing apparatus" described above, as FIGS. **20**A and **20**B, the case is described in which the manipulator **510** moves the hand **511** to the side opposite to the side on which the electric wire cutting device **10** is located with respect to the winding drum **521**, and then the electric wire extracting device **50** processes the electric wire W. In a "second example of the operation of the electric wire processing apparatus", a case will be described in which the manipulator **510** moves the hand **511** to the same side as the side on which the electric wire cutting device **10** is located with respect to the winding drum **521**, and then the electric wire extracting device **50** processes the electric wire W.

FIGS. **31**A and **31**B to FIGS. **43**A and **43**B are diagrams schematically depicting an example of an operation of the electric wire processing apparatus according to the embodiment of the invention. "A" in the drawings is a plan view schematically illustrating a main part relating to the operation of the electric wire processing apparatus **1** when the electric wire processing apparatus **1** is seen from the top. "B" in the drawings is a side view schematically illustrating the main part relating to the operation of the electric wire processing apparatus **1** when the electric wire processing apparatus **1** is seen from the side. FIGS. **31**A and **31**B to FIGS. **43**A and **43**B illustrate a series of processes in which the electric wire processing apparatus **1** processes one electric wire W, and each of the drawings depicts one operation in this series of processes. After this series of processes is performed by the electric wire processing apparatus **1**, as illustrated in FIGS. **14**A and **14**B, the electric wire holding structure **700** including the electric wire W and the clamp **630** is completed in which three points of an annular electric wire bundle C formed in an annular shape by a several winding of one electric wire W are held by the clamps **630** and the electric wire is maintained in the annular shape. The operation of the electric wire processing apparatus **1** will be described below.

After the previous series of processes is completed by the electric wire processing apparatus **1**, as illustrated in FIGS. **31**A and **31**B, the leading end of the electric wire W cut by the electric wire cutting mechanism **170** of the electric wire cutting device **10** in the previous series of processes is in a state of staying on the electric wire cutting mechanism **170**. Further, the winding rib **612** of the electric wire winding mechanism **520** in the electric wire extracting device **50** is disposed in front of the electric wire feeding mechanism **140** of the electric wire cutting device **10**, whereby the winding rib **612** is located on a straight line through which the electric wire feeding mechanism **140** feeds the electric wire W.

First, as illustrated in FIGS. **32**A and **32**B, the electric wire feeding mechanism **140** feeds the electric wire W to the extent that the leading end of the electric wire W passes through the second chuck **152** of the electric wire gripping

mechanism **150**. Additionally, a length L**1** of the electric wire W fed by the operation illustrated in FIGS. **32**A and **32**B is measured.

Subsequently, as illustrated in FIGS. **33**A and **33**B, the second chuck **152** of the electric wire gripping mechanism **150** is closed to grip the electric wire W.

Subsequently, as illustrated in FIGS. **34**A and **34**B, the manipulator **510** moves the hand **511** adjacently to the electric wire winding mechanism **520** of the second chuck **152**, and the hand **511** grips the electric wire gripped by the second chuck **152**.

Subsequently, as illustrated in FIGS. **35**A and **35**B, the second chuck **152** of the electric wire gripping mechanism **150** is opened to release the gripped electric wire V. The "second example of the operation of the electric wire processing apparatus" differs from the "First example of the operation of the electric wire processing apparatus" in that the first chuck **151** of the electric wire gripping mechanism **150** is not involved in the operation. Therefore, the operation of changing the direction of the leading end of the electric wire to the reverse feeding direction from the forward feeding direction is not performed.

Subsequently, as illustrated in FIGS. **36**A and **36**B, the manipulator **510** moves the hand **511** to a position adjacent to the winding rib **612** and to the same position as the side where the electric wire cutting device **10** is located. At this time, the hand **511** is located on the straight line through which the electric wire W is fed by the electric wire feeding mechanism **140** when the electric wire processing apparatus **1** is viewed from the top as illustrated in FIG. **36**A, and is located at substantially the same height as the height at which the electric wire clip **620** is located when the electric wire processing apparatus **1** is viewed from the side as illustrated in FIG. **36**B. Further, as the hand **511** moves, the electric wire feeding mechanism **140** feeds the electric wire W. Additionally, a length L**2** of the electric wire W fed by the operation illustrated in FIGS. **36**A and **36**B is also measured. By the operation of the hand **511** and the electric wire feeding mechanism **140**, the electric wire W from the electric wire feeding mechanism **140** to the hand **511** is located on the straight line through which the electric wire W is fed by the electric wire feeding mechanism **140** when the electric wire processing apparatus **1** is viewed from the top as illustrated in FIG. **36**A, and the electric wire W extending from the hand **511** is suspended by its own weight so as to draw a U-shape between the electric wire cutting device **10** and the electric wire extracting device **50** when the electric wire processing apparatus **1** is viewed from the side as illustrated in FIG. **36**B. With such a positional relation of the electric wire W, the electric wire W wound around the winding rib **612** can be easily collected in the recess portion **619** of the guide plate **615** when the electric wire W is wound around the winding rib **612** by the subsequent operation.

Subsequently, as illustrated in FIGS. **37**A and **37**B, the manipulator **510** moves the hand **511** adjacently to the electric wire clip **620** provided on the winding drum **521**, and thus the leading end of the electric wire W gripped by the hand **511** is pushed between the pair of pinching elements **621** of the electric wire clip **620**. At this time, as illustrated in FIG. **37**A, the hand **511** is rotated in a yaw direction, and thus a part of the leading end of the electric wire W partially protrudes to the side opposite to the base frame **611** of the winding rib **612**. Further, as illustrated in FIG. **37**B, the hand **511** is rotated in a pitch direction so that the depth direction of the electric wire clip **620** corresponding to the position of the electric wire clip **620** coincides with the direction in which the leading end of the electric wire W extends (in other words, the pinching direction of the article to be pinched between the pair of pinching elements **621** of the electric wire clip **620** is orthogonal to the direction where the leading end of the electric wire W extends).

Subsequently, as illustrated in FIGS. **38**A and **38**B, the manipulator **510** opens the hand **511** to release the electric wire W which is gripped.

Subsequently, as illustrated in FIGS. **39**A and **39**B, the manipulator **510** moves the hand **511** to an initial position.

Subsequently, as illustrated in FIGS. **40**A and **40**B, the electric wire winding mechanism **520** drives the motor **522** to rotate the winding drum **521**. The winding drum **521** rotates clockwise in FIG. **40**B. During the operation illustrated in FIGS. **40**A and **40**B, the electric wire feeding mechanism **140** does not feed the electric wire W, so that the electric wire W slackened between the electric wire cutting device **10** and the electric wire extracting device **50** is wound around the winding rib **612** by the rotation of the winding drum **521**.

Subsequently, as illustrated in FIGS. **41**A and **41**B, the electric wire winding mechanism **520** drives the motor **522** to rotate the winding drum **521**. During the operation illustrated in FIGS. **41**A and **413**, the electric wire feeding mechanism **140** feeds the electric wire W. A length L**3** of the electric wire W fed by the operation illustrated in FIGS. **41**A and **41**B is also additionally measured. At this time, the electric wire feeding mechanism **140** controls the amount of electric wire W to be fed and the electric wire winding mechanism **520** controls the number of rotations of the winding drum **521** such that the length of the electric wire W fed by the electric wire feeding mechanism **140** per time is equal to the length of the electric wire W wound around the outer circumferential surface of the winding rib **612** per time. FIGS. **41**A and **413** illustrate a state in which the winding drum **521** rotates several times and the electric wire W is wound around the winding rib **612** several times. Thereafter, when the total value of the lengths (L**1**, L**2**, and L**3**) of the electric wire fed in three operations reaches a predetermined length, the electric wire feeding mechanism **140** stops the feeding of the electric wire W, and the electric wire winding mechanism **520** stops the rotation of the winding drum **521**.

Subsequently, as illustrated in FIGS. **42**A and **42**B, the second chuck **152** of the electric wire gripping mechanism **150** is closed to grip the electric wire W. Subsequently, the lower blade of the electric wire cutting mechanism **170** approaches the third electric wire guide **130** to cut the electric wire W.

Subsequently, as illustrated in FIGS. **43**A and **43**B, the second chuck **152** of the electric wire gripping mechanism **150** is opened to release the gripped electric wire W. Subsequently, the electric wire winding mechanism **520** drives the motor **522** to rotate the winding drum **521**. During the operation illustrated in FIGS. **43**A and **43**B, the electric wire feeding mechanism **140** does not feed the electric wire W. The other end of the electric wire W gripped by the second chuck **152** of the electric wire gripping mechanism **150** in FIGS. **42**A and **42**B is wound around the winding rib **612** by the rotation of the winding drum **521**. Thus, as illustrated in FIGS. **43**A and **43**B, the total extension length of the electric wire W cut into a predetermined length is wound around the winding rib **612**.

Thereafter, similarly to the operation described with reference to FIGS. **29**A to **30**B in the "first example of the operation of the electric wire processing apparatus", three

clamps **630** are attached to the annular electric wire bundle C wound around the winding rib **612**, the leading end of the electric wire is detached from the electric wire clip **620**, and the annular electric wire bundle C is removed from the winding rib **612**. Thus, as illustrated in FIG. **13**, the clamps **630** holds three points of the electric wire bundle C formed in an annular shape by the winding of one electric wire, and thus the annular electric wire bundle C is maintained in a state of the annular shape.

As described above with reference to FIGS. **31**A to **43**B, the electric wire processing apparatus according to the embodiment of the invention processes one electric wire W into the electric wire holding structure **700**. According to the electric wire holding structure **700**, even in the case of manufacturing a wire harness using a long electric wire longer than a normal length, there is no need for the worker to deform the electric wire to have a shape and a size suitable for conveying the long electric wire to an automatic machine which processes the electric wire. Further, since the shape of the electric wire holding structure **700** is maintained in the annular shape, the electric wire holding structure **700** may be conveyed to the automatic machine for processing the electric wire by being hung on a hook, and thus the conveyance of the electric wire holding structure **700** is also easily automated. Thus, according to the electric wire processing apparatus and the electric wire processing method of the embodiment of the invention, and the electric wire holding structure used in the electric wire processing apparatus and the electric wire processing method, it is possible to obtain an excellent effect of contributing to improvement in productivity when the long electric wire is conveyed to the automatic machine for processing the electric wire.

Here, the characteristics of the electric wire processing apparatus, the electric wire processing method, and the electric wire holding structure of the above-described embodiment according to the invention will be collectively exemplified in brief by following [1] to [12].

[1] An electric wire processing apparatus (**1**) including:

a gripping mechanism (a first chuck **151** and a hand **511**) capable of gripping a part of an electric wire (W);

a driving mechanism (a rotating mechanism **160** and a motor **512**) that drives the gripping mechanism;

an electric wire winding mechanism (**520**) that winds the electric wire; and

a rotating mechanism (a motor **522**) that rotates and drives the electric wire winding mechanism, wherein

the electric wire winding mechanism includes a winding drum (**521**) on which the electric wire is wound, an electric wire clip (**620**) provided on the winding drum to hold a leading end of the electric wire, and a holding member (a clamp **630**) that holds an electric wire bundle wound around the winding drum in an annular shape,

the driving mechanism moves the gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip,

the rotating mechanism rotates the winding drum in a state where the leading end of the electric wire is held on the electric wire clip so that the electric wire is wound around the winding drum; and

the holding member holds the electric wire bundle wound around the winding drum in the annular shape.

[2] The electric wire processing apparatus according to [1], further including:

an electric wire cutting device (**10**) that cuts the electric wire to a predetermined length and feeds the cut electric wire; an

an electric wire extracting device (**50**) that receives the electric wire fed from the electric wire cutting device, wherein

the electric wire cutting device includes a first gripping mechanism (the first chuck **151**) serving as the gripping mechanism,

the electric wire extracting device includes a second gripping mechanism (the hand **511**) serving as the gripping mechanism, a second driving mechanism (the motor **512**) that drives the second gripping mechanism and serves as the driving mechanism, the electric wire winding mechanism, and the rotating mechanism,

the first gripping mechanism grips the leading end of the electric wire fed by the electric wire cutting device when the leading end is fed,

the second gripping mechanism grips the leading end and receives the electric wire when the first gripping mechanism grips the leading end of the electric wire, and

the second driving mechanism moves the second gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip.

[3] The electric wire processing apparatus according to [2], wherein

the electric wire cutting device further includes a first driving mechanism (the rotating mechanism **160**) that drives the first gripping mechanism and serves as the driving mechanism, and

the first driving mechanism drives the first gripping mechanism so that a direction of the leading end of the electric wire gripped by the first gripping mechanism is reversed from a forward feeding direction to a reverse feeding direction.

[4] The electric wire processing apparatus according to any one of [1] to [3], wherein

the winding drum includes a hollow cylindrical body (a winding rib **612**) around which the electric wire is wound,

the cylindrical body is provided with a notch (**613**) which is recessed downward in an axial direction from an upper end in the axial direction, and

the electric wire clip is accommodated and attached in the notch so that an electric wire pinching direction coincides with a radial direction of the cylindrical body.

[5] The electric wire processing apparatus according to [4], wherein

the driving mechanism rotates the gripping mechanism, which grips the leading end of the electric wire, to be in a state where the leading end of the electric wire is inclined with respect to a plane orthogonal to the axial direction of the cylindrical body, and moves the gripping mechanism toward the electric wire clip.

[6] The electric wire processing apparatus according to [4], wherein

the driving mechanism rotates the gripping mechanism, which grips the leading end of the electric wire, to be in a state where the electric wire pinching direction of the electric wire clip is orthogonal to a direction in which the leading end of the electric wire extends, and moves the gripping mechanism toward the electric wire clip.

[7] An electric wire processing method including:

moving a gripping mechanism (a first chuck **151** and a hand **511**), which grips a leading end of an electric wire (W), toward an electric wire clip (**620**) for holding the leading end of the electric wire to hold the leading end on the electric wire clip;

rotating a winding drum (**521**), on which the electric wire clip is provided, in a state where the leading end of the

electric wire is held on the electric wire clip so that the electric wire is wound around the winding drum; and

attaching a holding member (a clamp **630**) to an electric wire bundle (C) wound around the winding drum in the annular shape.

[8] The electric wire processing method according to [7], further including:

gripping the leading end of the electric wire fed by an electric wire cutting device (**10**), using a first gripping mechanism (the first chuck **151**) serving as the gripping mechanism included in the electric wire cutting device that cuts the electric wire to a predetermined length and feeds the cut electric wire, when the leading end is fed;

gripping the leading end and receives the electric wire, using a second gripping mechanism (the hand **511**) serving as the gripping mechanism included in an electric wire extracting device (**50**) that receives the electric wire fed from the electric wire cutting device, when the first gripping mechanism grips the leading end of the electric wire; and

moving the second gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip.

[9] The electric wire processing method according to [8], wherein

the first gripping mechanism is driven so that a direction of the leading end of the electric wire gripped by the first gripping mechanism is reversed from a forward feeding direction to a reverse feeding direction.

[10] The electric wire processing method according to any one of [7] to [9], wherein

the winding drum includes a hollow cylindrical body (a winding rib **612**) around which the electric wire is wound, the cylindrical body is provided with a notch (**613**) which is recessed downward in an axial direction from an upper end in the axial direction, and the electric wire clip is accommodated and attached in the notch, and

the gripping mechanism, which grips the leading end of the electric wire, is rotated to be in a state where the leading end of the electric wire is inclined with respect to a plane orthogonal to the axial direction of the cylindrical body, and the gripping mechanism is moved toward the electric wire clip.

[11] The electric wire processing method according to any one of [7] to [9], wherein

the winding drum includes a hollow cylindrical body (a winding rib **612**) around which the electric wire is wound, the cylindrical body is provided with a notch (**613**) which is recessed downward in an axial direction from an upper end in the axial direction, and the electric wire clip is accommodated and attached in the notch, and

the gripping mechanism, which grips the leading end of the electric wire, is rotated to be in a state where an electric wire pinching direction of the electric wire clip is orthogonal to a direction in which the leading end of the electric wire extends, and the gripping mechanism is moved toward the electric wire clip.

[12] An electric wire holding structure (**700**) including:

an electric wire (W); and

a holding member (a clamp **630**) that holds an electric wire bundle (C), wherein

the electric wire is wound several times to form an annular shape, and is held by the holding member to maintain the annular shape.

[13] The electric wire holding structure according to [12], wherein

the electric wire is held at three or more places by the holding member to maintain the annular shape.

What is claimed is:

1. An electric wire processing apparatus comprising:

a gripping mechanism that is capable of gripping a part of an electric wire;

a driving mechanism that drives the gripping mechanism;

an electric wire winding mechanism that winds the electric wire; and

a rotating mechanism that rotates and drives the electric wire winding mechanism, wherein:

the electric wire winding mechanism includes:

a winding drum on which the electric wire is wound,

an electric wire clip provided on the winding drum to hold a leading end of the electric wire, and

a holding member that holds an electric wire bundle wound around the winding drum in an annular shape,

the driving mechanism moves the gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip,

the rotating mechanism rotates the winding drum in a state where the leading end of the electric wire is held on the electric wire clip so that the electric wire is wound around the winding drum,

the holding member holds the electric wire bundle wound around the winding drum in the annular shape,

the winding drum includes a hollow cylindrical body around which the electric wire is wound,

the cylindrical body is provided with a notch which is recessed downward in an axial direction of the cylindrical body from an upper end of the cylindrical body in the axial direction, and

the electric wire clip is accommodated and attached in the notch so that an electric wire pinching direction coincides with a radial direction of the cylindrical body.

2. The electric wire processing apparatus according to claim **1**, further comprising:

an electric wire cutting device that cuts the electric wire to a predetermined length and feeds the cut electric wire; and

an electric wire extracting device that receives the electric wire fed from the electric wire cutting device, wherein

the electric wire cutting device includes a first gripping mechanism serving as the gripping mechanism,

the electric wire extracting device includes a second gripping mechanism serving as the gripping mechanism, a second driving mechanism that drives the second gripping mechanism and serves as the driving mechanism, the electric wire winding mechanism, and the rotating mechanism,

the first gripping mechanism grips the leading end of the electric wire fed by the electric wire cutting device when the leading end is fed,

the second gripping mechanism grips the leading end and receives the electric wire when the first gripping mechanism grips the leading end of the electric wire, and

the second driving mechanism moves the second gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip.

3. The electric wire processing apparatus according to claim **2**, wherein

the electric wire cutting device further includes a first driving mechanism that drives the first gripping mechanism and serves as the driving mechanism, and

the first driving mechanism drives the first gripping mechanism so that a direction of the leading end of the

electric wire gripped by the first gripping mechanism is reversed from a forward feeding direction of the electric wire cutting device to a reverse feeding direction of the electric wire cutting device.

4. The electric wire processing apparatus according to claim **1**, wherein

the driving mechanism rotates the gripping mechanism, which grips the leading end of the electric wire, to be in a state where the leading end of the electric wire is inclined with respect to a plane orthogonal to the axial direction of the cylindrical body, and moves the gripping mechanism toward the electric wire clip.

5. The electric wire processing apparatus according to claim **1**, wherein

the driving mechanism rotates the gripping mechanism, which grips the leading end of the electric wire, to be in a state where the electric wire pinching direction of the electric wire clip is orthogonal to a direction in which the leading end of the electric wire extends, and moves the gripping mechanism toward the electric wire clip.

6. An electric wire processing method comprising:

moving a gripping mechanism, which grips a leading end of an electric wire, toward an electric wire clip for holding the leading end of the electric wire to hold the leading end on the electric wire clip;

rotating a winding drum, on which the electric wire clip is provided, in a state where the leading end of the electric wire is held on the electric wire clip so that the electric wire is wound around the winding drum; and

attaching a holding member to an electric wire bundle wound around the winding drum in an annular shape, wherein:

the winding drum includes a hollow cylindrical body around which the electric wire is wound, the cylindrical body is provided with a notch which is recessed downward in an axial direction from an upper end in the axial direction, and the electric wire clip is accommodated and attached in the notch, and

the gripping mechanism, which grips the leading end of the electric wire, is rotated to be in a state where an electric wire pinching direction of the electric wire clip is orthogonal to a direction in which the leading end of the electric wire extends, and the gripping mechanism is moved toward the electric wire clip.

7. The electric wire processing method according to claim **6**, further comprising:

gripping the leading end of the electric wire fed by an electric wire cutting device, using a first gripping mechanism serving as the gripping mechanism included in the electric wire cutting device that cuts the electric wire to a predetermined length and feeds the cut electric wire, when the leading end is fed;

gripping the leading end and receives the electric wire, using a second gripping mechanism serving as the gripping mechanism included in an electric wire extracting device that receives the electric wire fed from the electric wire cutting device, when the first gripping mechanism grips the leading end of the electric wire; and

moving the second gripping mechanism, which grips the leading end of the electric wire, toward the electric wire clip to hold the leading end on the electric wire clip.

8. The electric wire processing method according to claim **7**, wherein

the first gripping mechanism is driven so that a direction of the leading end of the electric wire gripped by the first gripping mechanism is reversed from a forward feeding direction of the electric wire cutting device to a reverse feeding direction of the electric wire cutting device.

9. The electric wire processing method according to claim **6**, wherein

the winding drum includes a hollow cylindrical body around which the electric wire is wound, the cylindrical body is provided with a notch which is recessed downward in an axial direction from an upper end in the axial direction, and the electric wire clip is accommodated and attached in the notch, and

the gripping mechanism, which grips the leading end of the electric wire, is rotated to be in a state where the leading end of the electric wire is inclined with respect to a plane orthogonal to the axial direction of the cylindrical body, and the gripping mechanism is moved toward the electric wire clip.

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